The Electrical World.

VOL. XXXI. NEW YORK, MARCH 5, 1898. No. 10.

PUBLISHED EVERY SATURDAY BY

THE W. J. JOHNSTON COMPANY,

253 Broadway, New York.

Telephone Call: Cortlandt 924. Cable Address: "Electrical," New York.

New England Office, 620 Atlantic Ave., Boston.
Western Office, 936 Monadnock Block, Chicago.
Philadelphia Office, 929 Chestnut Street.

SUBSCRIPTION IN ADVANCE, ONE YEAR, $3.00,
In the United States, Canada or Mexico; other foreign countries, $6.00.

In requesting your address changed give OLD as well as new address.

Now in its third decade, THE ELECTRICAL WORLD is the Pioneer Electrical Journal of America, and has well maintained its lead. It has the largest Circulation of any electrical periodical, and is the best Advertising Medium.

THE ELECTRICAL WORLD'S Advertising Rates are much lower than those of any other similar publication, circulation considered, and vary according to space, position and number of insertions. Quotations promptly furnished.

Address and make drafts, orders, etc., payable to

THE ELECTRICAL WORLD,

253 Broadway, New York.

VOL. XXXI. NEW YORK, MARCH 5, 1898. No. 10.

CONTENTS.

Editorials ... 289
Electrically Operated Power Dredges ... 291
Photographic Investigation of a 150,000-Volt Power Discharge (*with Supplement*), by Chas. Proteus Steinmetz ... 294
The Potter's Wheel—Ancient and Modern ... 295
The Precise Comparison of Very Small Resistances, by Samuel Sheldon ... 296
Water Power Developments in Montana ... 296
London Electric Light Stations, I., by Herbert C. Gunton ... 297
Telegraph Service in Mexico ... 299
A 100,000-Volt Testing Set, by C. E. Skinner ... 300
A High-Tension Switch ... 302
The Single-Phase Induction Motor, by Chas. Proteus Steinmetz ... 303
The Induction Motor as an Arc Regulator ... 305
Separation of the Iron Losses of a Transformer, by Prof. H. S. Carhart ... 306
Digest of Current Electrical Literature, compiled by Carl Hering ... 307
Electric Car Heating ... 310
Siphon Condenser ... 311
A New Telephone Switchboard ... 311
Electric Light at the Omaha Exposition ... 312
New Telephone Manufacturing Quarters ... 312
High-Tension Current Bell ... 313
A New Telephone Manufacturing Company ... 313
New Electrical Marine Projector ... 313
Carbon Resistances ... 313
Model Experimental Apparatus ... 314
Some Important Apparatus of New Design ... 314
Improved Telephone ... 315
Electric Percussion Drill ... 315
A New Motor Suspension ... 315
Separator with Automatic Discharge ... 315
Making Belts for Thirty Years ... 316
A Compact Isolated Plant ... 316
Detachable Electric Light Windlass ... 316
Improved Steam Engine Indicator ... 316
Departments:
Financial Intelligence ... 317
Special Correspondence ... 317
General News ... 320
Legal Notes ... 321
Personal Notes ... 321
Obituary Notes ... 322
Trade and Industrial Notes ... 322
Business Notice ... 323
Illustrated Record of Electrical Patents ... 324

BEGINNING ITS TWENTY-FIFTH YEAR.

This issue of THE ELECTRICAL WORLD is the first number of the paper's twenty-fifth year. On anniversary occasions it is customary to pause and look backward. As the pioneer in its field, THE ELECTRICAL WORLD has had the pleasant duty of witnessing and recording all the great developments in electrical engineering as they have occurred. Established March 1, 1874, under a different title and as a semi-monthly journal for telegraph operators, it in 1876 announced the advent of the telephone, later of the modern electric light, and later still, of the now familiar electric railway. The electric arts have grown during the period covered by this retrospect from practically nothing to their present comparative perfection. There are, by the way, two diametrically opposed ideas prevalent as to the present absolute state of the electrical development. The layman considers electricity to be "still in its infancy," while the professional man inclines a little too much to the opposite opinion, considering that electricity is nearing the highest point of its development. An examination of the conditions during the last quarter of a century seems to show that the development has been as a rule more and more rapid year after year, and is now more rapid than it ever has been heretofore. The history of THE ELECTRICAL WORLD shows that in its growth it has kept pace with the wonderful development of its subject, and that it bears the same relation to-day to the greatly improved electrical arts that it did in 1874 to telegraphy, which was in that day the only practical application of electricity.

ELECTRICAL ENGINEERS FOR WAR SERVICE.

There has been formed in England a corps of volunteer electrical engineers for service in time of war, the work having been encouraged by the English Institution of Electrical Engineers, from among the members of which the new corps will probably be largely recruited. A similar action in this country would undoubtedly be of considerable value, electrical engineers being, as a rule, skilled not only in their own particular art, but largely conversant with the principles and practices of mechanical and civil engineering. This country already has its National Guard and Naval Reserves made up of men drawn from all professions, and therefore, as a rule, quite incapable of quickly comprehending any machinery of great complexity. A corps of skilled engineers could, in case of emergency, board a warship and become quite proficient in a few hours' time in the handling of the intricate propelling and fighting machinery, which would for days or weeks be a complete riddle to men of purely business training.

In October, 1890, a paper was read before the New York Electrical Society by Lieut. Bradley A. Fiske, entitled "The Civilian Electrician in Modern War." This paper, which was reprinted in THE ELECTRICAL WORLD of November 1 of that year, brought out ably the advantages of the plan mentioned above, and excited no little interest, which brought, however, no practical results. The present lively interest in our national defenses might now make the plan more likely of realization.

ELECTRIC POWER FOR ROUGH WORK.

Not very many years ago every electric motor sold was accompanied by a list of directions, prominent among which were some such advices as the following: "Keep in a cool, dry place, free from dust. Avoid overloads and sudden shocks to the driven machinery. Start slowly and without load if possible." The electric motor was considered and was a delicate instrument, susceptible of easy injury, and necessitating careful treatment. Since the application of electric power to traction, however, and the development of suitable machinery for this severe work, the motor has become available for the roughest and most trying situations. In another column will be found a description of the application of motors to power shoveling and dredging apparatus, a use which involves about as severe treatment of a motor as anything possibly could. Exposed to dust, mud, water and grease, driving cumbersome apparatus, digging into material of a very variable resistance, sometimes catching in the dipper great boulders or striking bed rock, the apparatus all made so strong that nothing can give, but every strain must come right back to the armature, the motor has no easy task. In this work the steam engine has heretofore enjoyed a universal monopoly, the flexibility of the steam motor being of great advantage. With proper design the steam engine could be made of insufficient strength to break any part of the power transmitting machinery in case the parts to be moved became absolutely bound. The steam engine, if overloaded, simply stops. With the electric motor, on the contrary, any increased load, and consequent reduction of speed, increases the torque of the motor, a definite limit to this being fortunately obtainable by means of circuit breakers.

Great flexibility and a wide range of speed without great change of torque are almost imperative needs in motors used for such purposes, speed regulation being, of course, of no value whatever. For this reason the series motor is preferred to the shunt, the series motor, even on constant potential circuits, being capable of working without resistance over a considerable range of speed, automatically reducing its own speed as the load rises and vice versa. Even with a series motor, however, on constant potential circuits without choking resistances the elasticity is not all that it might be. The series motor on constant current circuits, now almost out of use, possesses valuable features for such work. Its torque is uniform, whatever its speed, and if the braking effect of its load is greater than this fixed torque which it will give, it simply stops. There is no short circuiting effect or blowing of fuses or opening of circuit breakers. It does not, therefore, require quick operating automatic apparatus to cut off the power from it in case of overload, to prevent it overstraining any of the parts worked. The series motor operated on constant potential circuits enjoys to a certain extent the same features, which can be increased at the expense of reduced efficiency, by inserting resistances in series with it. The shunt motor on constant potential circuits is the least satisfactory in this regard, its general tendency being to run uniformly at the same speed, no matter what happens to its load.

The alternating current induction motors have a peculiarity adapting them most beautifully to such work. While they tend to run at a more or less fixed speed with ordinary loads, dependent somewhat upon the resistance in their secondaries, with severe overloads, even with short-circuited secondaries, they pull right up and stop without serious short circuiting effects or strain on the driving mechanism. This is owing to the inductive choking effects of their windings. Their value in this respect seems to be better appreciated in Europe than in this country, their use there for cranes, windlasses, hoists, etc., being quite general.

STREETS VERSUS STREET RAILWAYS.

In the recent inaugural address of the president of the English Society of Engineers there were brought out some important points concerning the *raison d'etre* of street railways or tramways. If in the old days of the horse car there had been no considerable difference between the tractive effort on pavements and rails there would have been no cause for street railways. The use of vehicles riding freely over the pavement is in all respects superior to that of vehicles running on rails, with the single exception of the lower traction coefficient of the latter. Omnibuses require no special roadbed, are not confined to fixed routes on which such a roadbed is provided, are not blocked by an accident at any one point and are greatly superior to tram cars on these accounts. But the immensely greater tractive effort on the poorly constructed roads of the past necessitated the tramways. The speaker referred to above classed tramways as "metallic admission by engineers and the public of the badness of ordinary roads."

Now that the horse has been superseded by the electric motor for street railway work, this change necessitating the constant connection of the vehicle with either an overhead or an underground conductor, the reduction of the traction coefficient on pavements to a value equal to that on rails would not necessarily eliminate the use of the latter, as the vehicles would be necessarily confined by the necessities of the conducting system to fixed routes. If, however, in future the storage battery or any other mechanical means of propulsion, whereby the car is rendered independent of the conducting system, is developed to such an extent that it can compete with the trolley, the perfection of pavements would do away with the necessity for rails.

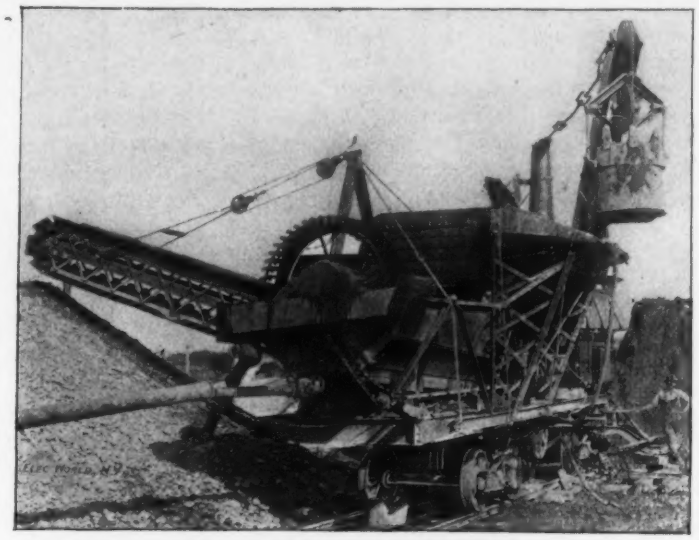
That our roadways will be enormously improved over their present crude condition there is not the slightest doubt. The horse is a very poor dynamometer and gives but a crude indication of the work he is doing. The development of motor vehicles, especially electrical vehicles, with which an ammeter shows immediately the great difference between a good and a bad pavement, is opening the eyes of road users to the advantages of better pavements. Belgian block pavements, especially with steel tired wheels, involve a most deplorable waste of power in the pounding, rattling and shaking of the vehicles running over them. Macadam roads are non-resilient. Asphalt pavements are better than either, except in hot weather, when their resilience often falls far below that of macadam. A rigid, flat pavement would be ideal for motor vehicles, but is out of the question while horses are used. With the passing of the horse, however, the pavements can and will be improved and may reach such a state of perfection that there will be no advantage in rails. In this case if light automobile vehicles are perfected, the street railway may become a thing of the past.

Meeting of the National Electric Light Association.

The next meeting of this association will be held in Chicago, Ill., on June 7, 8 and 9, 1898, with headquarters at the Auditorium Hotel. The rates for accommodation at this hotel will be from $3.50 to $5.00 per day on the American plan, or $2.00 to $4.00 on the European plan. The hotel gives the association the use of its banquet hall for the meetings.

Electrically Operated Power Dredges.

One of the most trying applications of power developing machinery of any kind is that to power dredging and shoveling apparatus. A complete equipment of this kind, using electric motors throughout, has been developed by the Bennett Amalgamator Manufacturing Company, and put to use in Colorado in placer mining work.

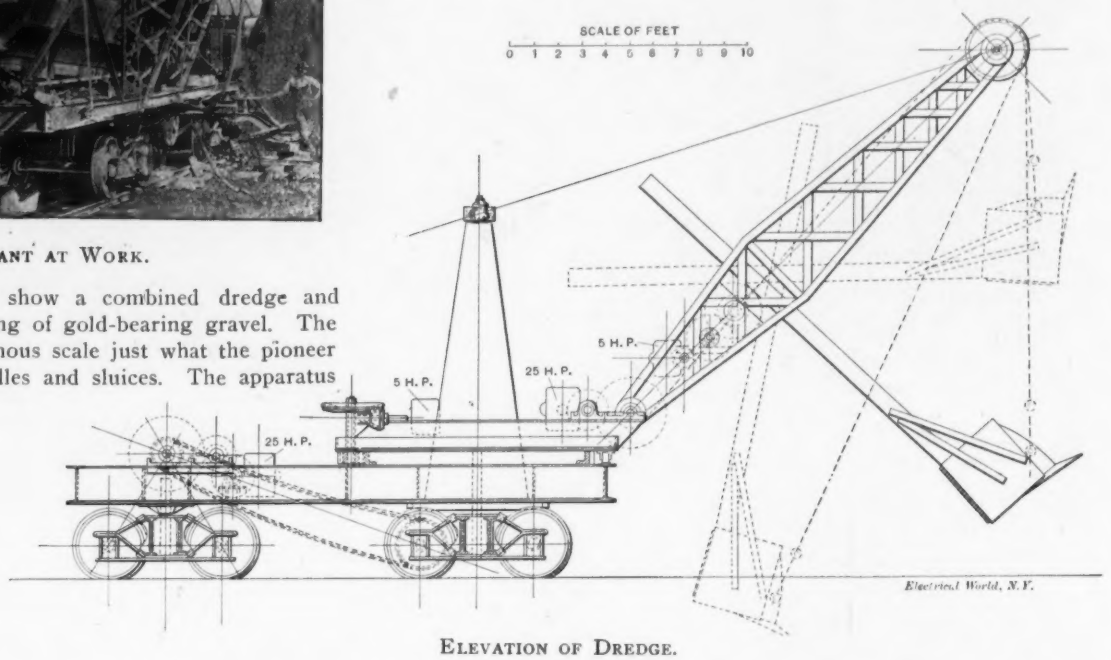


EXPERIMENTAL PLANT AT WORK.

The accompanying illustrations show a combined dredge and amalgamator for the placer working of gold-bearing gravel. The machine accomplishes on an enormous scale just what the pioneer miners effect with their pans, cradles and sluices. The apparatus consists essentially of a car with a scoop dredge mounted on a turn table at its forward end and a complete power amalgamating apparatus mounted on its other end. The whole machine is movable by power either forward and backward, sideways or up and down, so that it can be worked slowly over the most irregular surfaces, scooping up the gold-bearing earth as it goes along, extracting from it the valuable deposits and throwing away the tailings behind it.

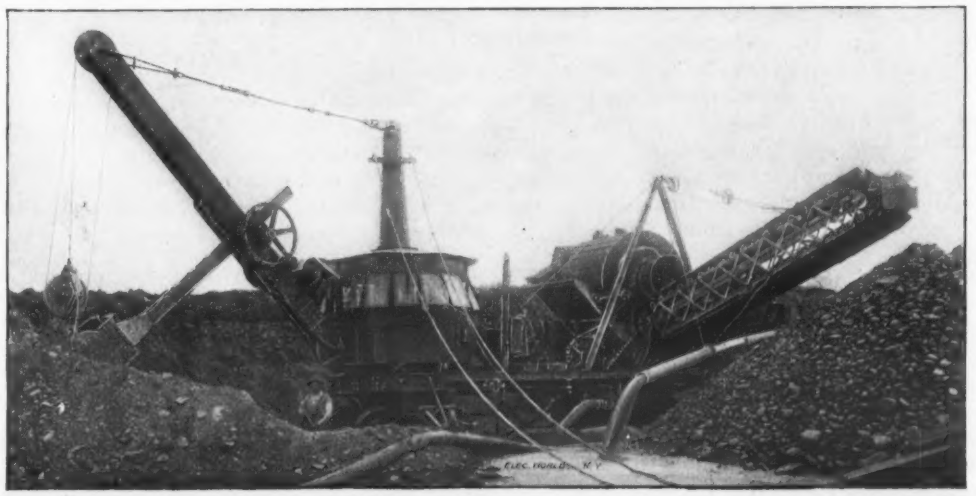
The group of illustrations on the next page shows the latest type of this plant, the total weight of which is about 90 tons. The car body, 40 feet long and 12 feet wide, is built up of 20-inch I beams in a most thorough and up-to-date manner. Every joint in the frame is machined to admit of the most perfect fitting of flanges and the joints are drawn together by special angles and seven-eighth-inch steel bolts, all holes being drilled and not punched. The car is supported on two trucks on 36-inch wheels. These trucks consist in part of narrow frames of 20-inch steel I beams, 20 feet long, running at right angles to the fore and aft line of the main car body. As may be seen in the illustrations, in the ends of these long transverse truck frames are wheels on which the whole car can be moved sideways. Framed to these transverse beams are also regular four-wheel trucks, and if the weight of the car is borne on them, the car can be rolled forward and backward. The weight of the main car body is brought on these truck-frames through heavy 5-inch steel king pins, powerful jack screws with worm and worm gear attachment being provided under each of the four corners of the main frame to level up the latter, no matter what the grade or side slope of the track may be. These jacks are operated either by hand or by a small motor. At the extreme ends of the transverse girders are mounted lifting jacks by which the whole car can be raised from all its wheels and rigidly supported when subjected to the strains and pushes of shoveling and digging. By means of these also the car can be lifted up from the longitudinal tracks and transverse tracks placed under the appropriate wheels, or vice versa, whenever it is desired to change the direction of its motion. In this way the heavy car can be moved with minimum labor over the most irregular ground and obstructions, and as it is arranged to dig 8 feet below its track level, it can excavate for itself a pit into which it can be lowered and from which it can be raised. The longitudinal tracks are 8-foot gauge and the transverse tracks 19-foot gauge.

The boom carrying the main dipper is mounted with a cab on the turn table revolving about a short stout mast. This mast is conical, built up of steel plates machined throughout and reinforced inside with ribs of 5-inch T bars. The whole thing is so solid that a pull on the top of the mast lengthwise of the car would lift the whole rear end of the car, together with the amalgamator, before endangering the mast and its connection with the platform. The periphery of the turn table is mounted on a series of trundle wheels running on a circular steel track, the annular centre of the table bearing on



ELEVATION OF DREDGE.

the mast through a ring of steel rollers. The main boom is double, the handle of the dipper running between the two steel I beams of the boom, the lower ends of which are hinged to heavy steel I beams on the turn table floor. Diametrically across the turn table from the boom joint is a vertical shaft projecting through the turn table floor and carrying on its lower end a steel pinion, with an 8-inch face, which engages with a 10-foot gear on the car body, concentric with the mast. Geared to this by bevel and spur gears is an L. W. P.-5 General Electric motor, by which the whole turn table, with boom and dipper, is rotated in a horizontal plane about the mast. The upper end of the boom is firmly held to a collar at the top of the



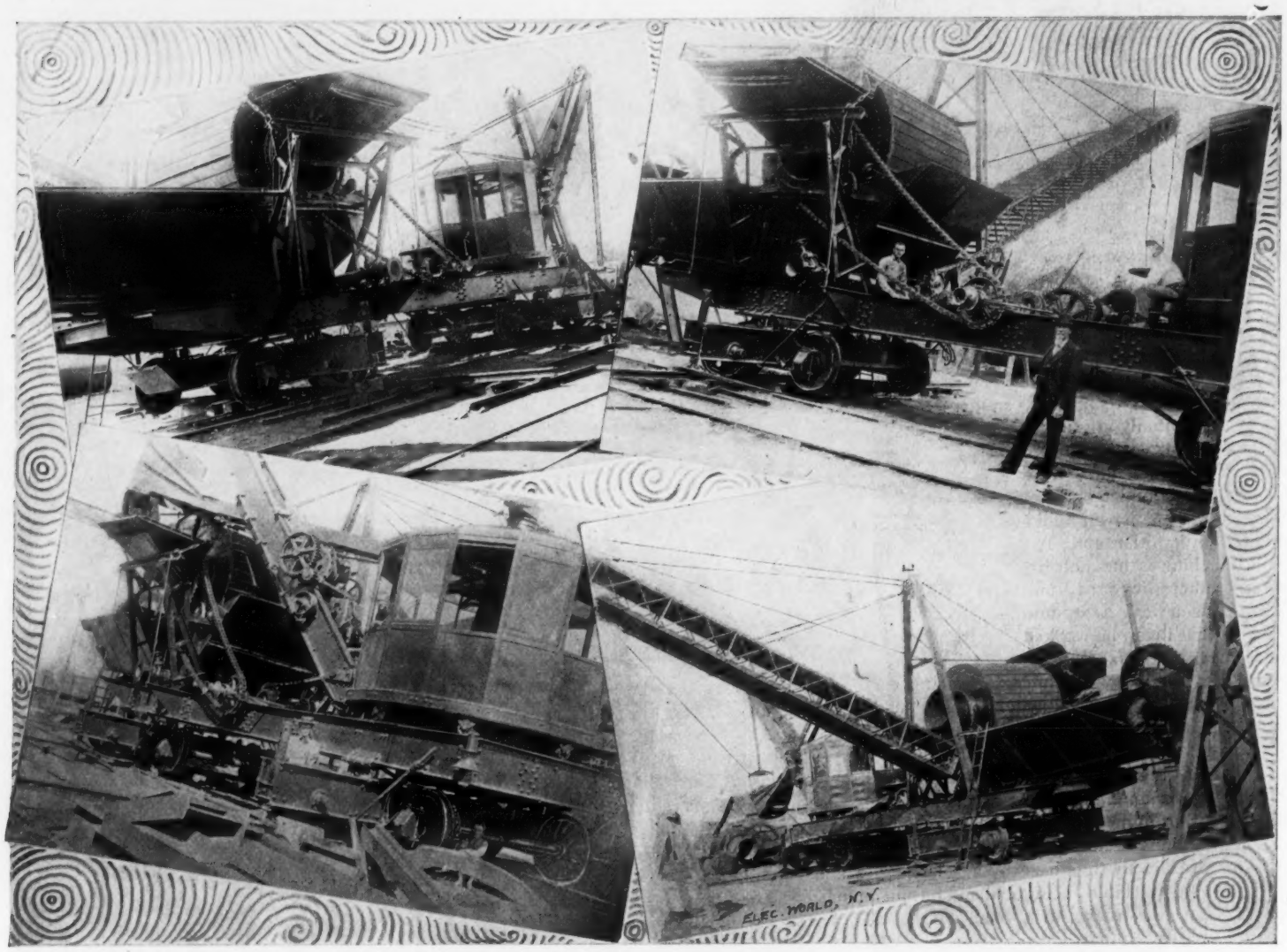
EXPERIMENTAL AMALGAMATOR AND DREDGE.

mast by means of a pair of heavy steel cables, the inclination of the boom being invariable.

The dipper handle is articulated about a joint near the middle of the main boom and the dipper is raised and lowered by a flat crucible steel hoisting cable 6 inches wide. This passes over a sheave at the outer end of the boom and runs down to a drum mounted concentrically with the main hinged joint of the boom and turn table, this drum being driven through double reduction spur gear by a 25-hp G. E. 800 motor. The drum is small, giving great leverage to the driving train at the start when the dipper is in the ground, the flat rope winding on to the drum and increasing its effective diameter, thereby diminishing the speed reduction between the motor and the dipper as the latter rises.

Obviously all that is further needed to obtain complete control of the motions of the dipper is some method of working the dipper handle up and down through the main boom. This handle rolls freely on wheels mounted a little below the middle of the main boom and its lengthwise movements are effected by heavy flat steel cables, one attached to its upper end and two to its lower end, all of them being brought over a motor driven drum in such a way that if the drum is turned in one direction the upper cable is paid out, while the lower ones are drawn in, thus raising the dipper; while turning the drum in the other direction pays out the lower cables and draws in the upper, thus lowering the dipper. The drum is driven by a 5-hp (L. P. W.-5) motor through double reduction gearing. Thus by means of these three motors the turn table carrying the boom and dipper can be turned about a vertical axis, the dipper handle can be raised or lowered through the boom and the dipper itself can be rotated about the joint of the dipper handle and boom. The bottom of the dipper is hinged so that it can open, and is fastened when closed with a latch. In operation the turn table is swung to a suitable point for scooping up a dipperful of gravel. The dipper is lowered until its handle is about in a vertical line, when the bottom closes with a bang and latches automatically; the dipper is then run down in the gravel and is pulled up and forward by the hoisting cable, thus scooping up a load of earth. The turn table is then swung until the dipper hangs over the hopper of the amalgamator. At a proper point a lever attached to the latch strikes a spring target, opening the bottom of the dipper and allowing the charge to fall into the hopper.

The details of the amalgamator are the same as those of all Bennett amalgamators and are not of particular interest here. The apparatus is driven by a G. E. 800 motor mounted on the platform of the car, the power being transmitted by means of a heavy steel sprocket chain. The gear train of the same motor is connected by a clutch and another sprocket chain with one of the main axles of the forward truck, so that the car can be moved fore and aft by motor power when desirable. The method of supporting the revolving cylinder of the amalgamator is interesting. The material from the dipper is delivered into the cylinder through a large central opening at one end, and from it at the other end the tailings pass to an endless steel chain conveying apparatus, necessitating large openings in the ends of the cylinder. The latter is, therefore, mounted on a ball bearing, acting only through a segment of its circumference sufficient to support it, the balls returning from one end of the segment to the other through a ball race. Around this central opening is the sprocket wheel, on which acts the sprocket chain from the driving motor.



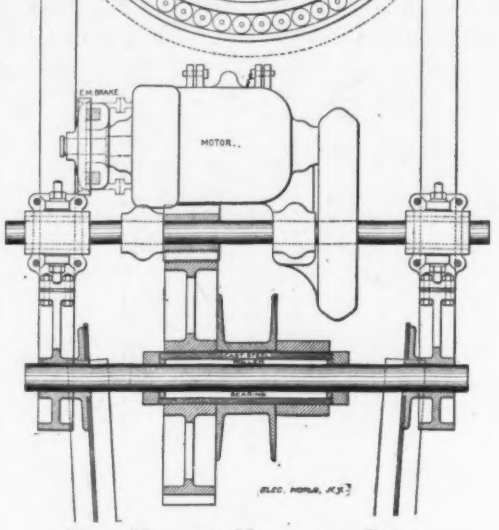
Views of Electrically Driven Dredge and Amalgamator.

In connection with the amalgamator a pump is employed capable of delivering 1600 gallons of water per minute under 100 pounds pressure. This is also motor driven. Another motor of 15 horsepower with a simple shunt winding is placed on the car body and connected with a centrifugal pump which receives the overflow from the amalgamator tank. This discharges through a pipe suspended below the tailings carrier, and the discharge water is delivered beyond the crest of the tailings pile, whence it drains off and leaves the working pit dry. A dynamo of 150-kw capacity serves to supply the

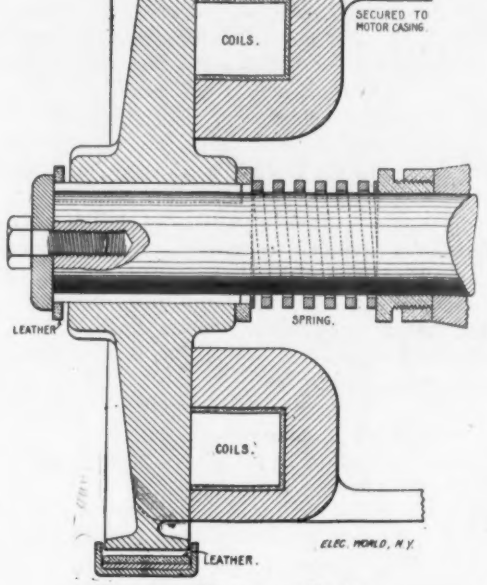
power for all these motors and is placed at any convenient location suitable for the use of water power or the convenient supply of fuel. The motors are all run at 500 volts, so that the dynamo can be at some distance from the work, and by means of alternating currents and rotary transformers distant water powers can be made use of when necessary.

This dredge has a capacity of over 200 cubic yards per hour of ordinary material, swinging its dipper twice per minute, cutting a circle 60 feet in diameter and capable of digging 8 feet below its own track level. The motors, with the exception of those running the amalgamator and pumps, are controlled by rheostatic reversing controllers, all mounted in the main cab on the turn table within reach of one man. The three motors running respectively the dipper handle, the dipper lifting cable and the turn table are all provided with electromagnetic brakes. These are not ordinary strap brakes applied by electromagnets, but are magnetic clutches. As shown in one of the accompanying drawings, the coils are wound in an iron casting fixed to the motor casing concentrically with the shaft on which the brake is applied. A cast iron disc keyed to the shaft to be retarded is arranged to be drawn up to this fixed casting by the magnetic field of force. A spring serves to release it again when the magnetic field dies away. Around the outer rim of this disc is arranged an ordinary strap brake arranged with a compound lever to be tightened or loosened by hand in case the current should fail. The circuit of the coil is controlled by the motor controller, and to avoid flashing or sparking from the highly inductive winding the coils are differentially wound, the current passing through the two windings in a reverse direction when the brake is thrown off, and one winding being open circuited when it is desired to apply the brake. This allows the inductive kick to exert itself on the other winding and prevents serious flashing at the controller contact. The amalgamator and pump motors, as they run continuously, are provided simply with starting rheostats. One man can handle the whole apparatus when necessary, and with two track layers or pit men the machine is well manned.

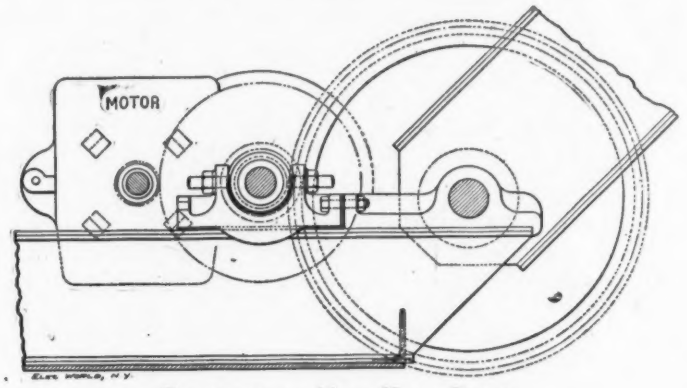
The company also builds river dredges on the same plan, the car body and trucks being replaced by a hull with appropriate propelling mechanism and powerful spuds for holding it when dredging. The hulls are steel barges, 105 feet long, 32 feet wide, and 7½ feet deep, divided into five water-tight compartments. There is a power plant in the hull and an amalgamator and dredging apparatus above the main deck, the whole provided with machine shop, forge, kitchen, dining room, store rooms, sleeping apartments, etc. The spuds of these machines are operated by small motors, so that it is possible at any time when the boat is under way to stop for a moment, take a dipper or two from the river bed, and test the contents, thus doing prospecting work in a most easy and satisfactory way. The main pump may be made to discharge through nozzles projecting laterally from the four quarters of the hull, giving with suitable valves a ready means of control of the boat's direction or a slow lateral or rotary motion.



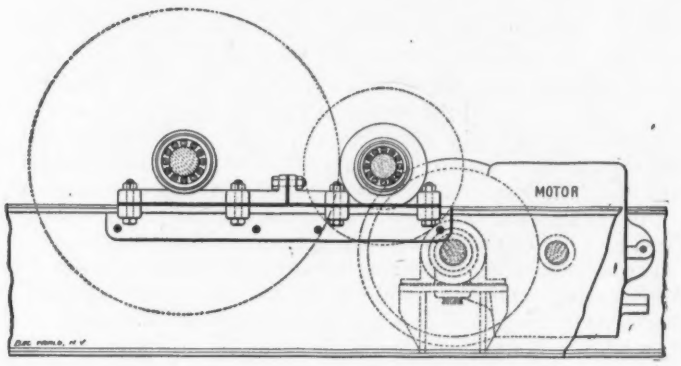
MAIN HOISTING MOTOR AND DRUM.



ELECTRO-MAGNETIC BRAKE.



ELEVATION OF MAIN HOIST DRIVE.



GEAR TRAIN OF MOTOR DRIVING AMALGAMATOR.

Aluminum for Army Equipment in France.

Aluminum has been adopted to take the place of sheet iron for the following camp utensils in use in the French army: The individual plate or bowl, canteen, quart cup, and the boiling pot and bowl for use of four men.

Progress on the Jungfrau Railway.

Notwithstanding the unseasonable weather this winter, work on the great tunnel for the Jungfrau railway has progressed rapidly. Electric drills have been at work since December 13, and the excavations are now electrically lighted, as is also the large building on the Eiger where the engineers and workmen are lodged.

It is announced that in July of this year the first portion of this bold undertaking will be in operation for a distance of 10 kilometers.

Photographic Investigation of a 150,000-Volt Power Discharge.

BY CHAS. PROTEUS STEINMETZ.

To investigate the phenomena taking place during a disruptive discharge at very high voltage and in a circuit of sufficient power to maintain an arc a series of photographs were taken, differing from each other by the length of exposure.

As discharge terminals there were used two one-half-inch brass spheres, separated from each other by 14 inches, and in some cases by 15 inches. The camera was focused on the discharge terminals, the generator field excited to give 150,000 volts effective at the discharge terminals, then the cap was taken off the lens, the generator switch closed, and thereby the disruptive discharge started, and the generator field switch opened after the discharge had lasted the desired time.

The generator was a smooth core 125-cycle single phaser, giving a wave very closely resembling a sine wave. The ratio of maximum to effective value of the generator wave is 1.42. The generator G, Fig. 1, feeds four 7.5-kw type F transformers F', stepping down by the ratio of 10 to 1. These transformers feed again four 7.5-kw type F transformers F'' stepping up by the ratio of 1 to 20, and these latter transformers feed four special oil transformers, H_1 H_2 H_3 H_4, of the ratio 1 to 18. These were connected in series with their high potential sides to the electrodes, thus giving a total ratio of 1 to 144.

The voltage was measured by a Weston voltmeter V in the low tension circuit. An extended series of preliminary investigations had shown that the high potential voltage can by these means be determined accurately within less than 1 per cent., irrespective of the capacity of the discharge circuit within certain limits.

The total impedance of the system, inclusive of the impedance of the generator, is reduced to the high potential discharge circuit:

$$Z = (80—390\ j)\ 10^8 \text{ ohms, or absolute,}$$
$$z = 398 \times 10^8 \text{ ohms.}$$

The generator excitation corresponded to a potential in the discharge circuit of 184,000 volts effective.

Thus, while before the discharge the voltage at the electrodes was 150,000 effective, at short circuit between the electrodes the current is .465 amperes effective, and the maximum output available in the discharge circuit between the electrodes is 35.5 kilowatts.

The photographs are numbered according to the length of exposure.*

In No. 1 the length of exposure was about one-half second, as short as the time interval between closing the generator main switch and opening the generator field switch could be made. In the ninth photograph the arc lasted about ten seconds. The tenth photograph is a short exposure of the discharge of an iron-clad alternator. Photographs Nos. 1, 2, 3, 4 and 10 are taken with small opening of the lens and 15 inches striking distance; Nos. 5 and 9 with large opening of the lens and 14 inches striking distance; Nos. 6, 7, 8 with medium opening of the lens and 14 inches striking distance.

The following phenomena appear to take place: An electrostatic discharge of oscillating nature strikes across the electrodes. This discharge starts an alternating arc between the electrodes which first follows the path of the discharge, then flares upward, in its centre first, due to the upward rise of the intensely heated air, while its sides eddy round in an erratic manner and then flare upward also. This arc never breaks spontaneously, but frequently jumps across space by bifurcation, and rises to a height considerably in excess of the distance of the electrodes. It finally assumes the shape of two flames issuing from the electrodes and curving sharply upward, joined at the top by bridges of flame in rapid and erratic motion. At the same time the two sides tend to separate from each other and to run back along the electrodes.

The oscillating discharge is of intense brilliancy and therefore shows, on all the photographs where a larger opening of the lens was used, as a dark line, due to the reversal of the photographic plate by over exposure (solarization).

It can best be studied on photographs Nos. 1, 2, 3, 4 and 10, where a small opening of lens was used.

It is very sharply defined, has the usual zigzag course of an electrostatic discharge, but consists of a number of distinct oscillations which follow only approximately, but not completely, the same path. They look like threads twisted loosely together. Two oscillations can be distinguished throughout, one, apparently the first discharge, of greater width and brilliancy than the other or return stroke. On most photographs on many places a third oscillation can be distinguished as a line interwoven with the first two, but still fainter. In a few instances it begins to get blurred.

In photograph No. 2 at one place a fourth oscillation seems to be marked, already considerably blurred by expanding into an arc.

These oscillations do not occur in parallel paths, but in paths interwoven with each other.*

The existence of these successive oscillations and the distinct courses followed by them are very remarkable and were quite unexpected. Since the self induction and capacity of the system are comparatively small and the available power far in excess of that necessary to maintain an arc, I expected that the first discharge would short circuit the spark gap and start an arc. The existence of successive oscillations following distinct courses seems to prove that the dielectric or disruptive strength of air is not completely broken down by a single discharge, as is generally assumed, and not even greatly weakened, since the second and third oscillation follow only approximately the same path. Thus a number of successive discharges or oscillations seem necessary to gradually weaken the dielectric strength of air so as to allow an arc to start.

Second—The arc established by the oscillating spark first follows its path, but gradually leaves it. Each half wave of the alternating current is marked by a striation on the photograph. These striations follow each other in parallel curves. The gradual drift of the arc from the path of the original spark is best seen in photograph No. 5.

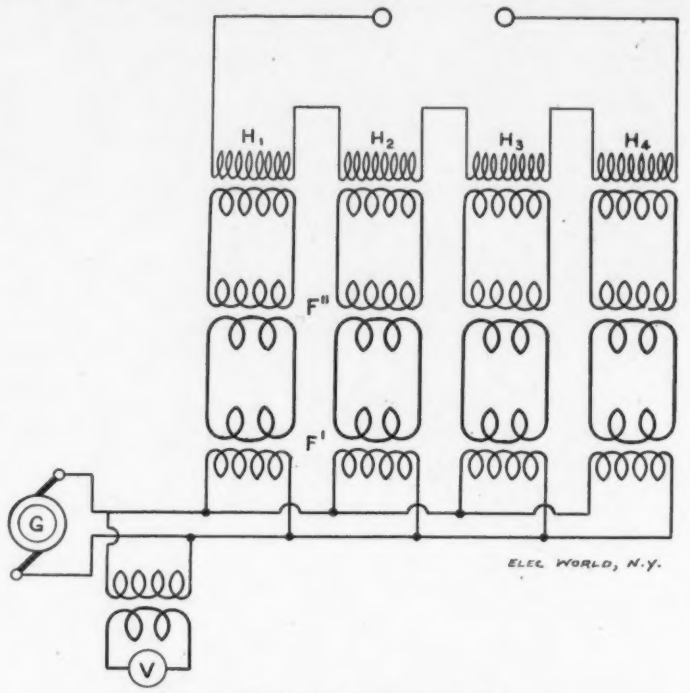


Fig. 1.—Diagram of Transformer.

Apparently the air, intensely heated by the arc, begins to rise up in some place, generally the centre, and thereby forces the air downward in some other place and thus forms a strong eddy. Photograph No. 1 shows an eddy in the form of a cone at the left lower side, and the beginning of an upward flare at the left near the centre.

Such an upward flare is shown also in photograph No. 2. In this photograph the arc seems to have left the original spark very rapidly and twisted in a remarkable manner, since the striations are in almost every direction. This photograph also shows what appears to be a bifurcation, that is a black space on the left side just above the spark. The arc has passed below this black space and above it, has never passed across this space and still has not been interrupted, since otherwise a second static spark would be visible. Thus the arc, while passing below the black space, must on either side have twisted upward until the sides of it met again above and joined, and afterward it broke below. This is still better shown in the bifurcation on photograph No. 4.

The upward flare and the eddy are also shown in photograph No. 3. This seems to express the mechanism best. The heated air rises upward and carries the centre of the arc up into a flare, but the upward current of air forces air downward on either side and thereby bends the sides of the arc down into cones or hollows, as seen in photographs Nos. 1, 2, 3, and most pronounced in photograph No. 7.

* See accompanying Supplemental Sheet.

* This stranded rope-like appearance of the static spark is shown in the photographs but is lost in the reproduction. It appears faintly in Fig. 6.—Editors.

Photograph No. 4 shows the upward flare in the centre of the arc well developed and the sides beginning to flare upward also. Photograph No. 4 shows a very curious spiral eddy just below the centre, and a bifurcation above the centre of the spark. On the right hand side of the latter the arc is seen drawn out toward the left over the black space, meeting the arc coming from the left side.

The exposure in this case was about one second.

Photograph No. 5 shows the upward flare of the arc completely developed, with a black space in the very centre where the arc has jumped across by joining again above and then breaking below.

This photograph also shows the running backward of the arc along both electrodes, due to the dynamic repulsion of the currents in the two sides of the arc which flow in opposite directions. This repulsion is shown also by the sharp upward bend of the side flames in the following photograph.

Photograph No. 5 shows the striations most markedly. Since the time between adjacent striations is that of a half period of 1-250 second, the rapidity of the upward motion of the air can be estimated from the distance of adjacent striations. Where they are furthest apart the air velocity must be about 10 feet per second.

The spark in photograph No. 5 is blurred, due to the large lens aperture used, and reversed or solarized. The exposure in this case was about two seconds.

Photographs Nos. 6, 7 and 8, taken with medium size lens opening and about four seconds exposure, show the electrostatic spark somewhat sharper, but generally reversed or solarized also, as a black line.

They show most pronouncedly the two flames issuing from the electrodes and bending sharply upward with no noticeable striations in them, since the arc was probably fairly stationary in these flames.

The top space of these photographs, however, is completely filled with striations of approximately horizontal direction and considerable distance from each other, showing that the arc bridging across the space between the two stationary terminal flames was in rapid eddying motion upward and downward.

A curious eddy is shown in the centre of photograph No. 7.

Photograph No. 9 shows a long exposure of about ten seconds. The striations are not noticeable any more, but only the centres of flames. This arc was accidentally broken and started over again, and thus shows two starting sparks.

The last photograph, No. 10, shows the disruptive discharge caused by an iron-clad alternator of the ordinary saw tooth wave form. It does not differ much from the previous photographs in its nature except that the discharge is somewhat fainter, due to the lesser power available in the discharge circuit in consequence of the high synchronous impedance of the iron-clad alternator (a 60-kw machine).

The conclusions drawn from these photographs are:

First—The discharge of a high potential circuit is always oscillating, even if sufficient power is behind the circuit to maintain an arc; and a number of successive oscillations are necessary to weaken the disruptive strength of air sufficiently to maintain an arc. Thus the dielectric strength of air is not reduced to zero by a single electrostatic discharge or rupture, but on the contrary is still sufficiently high to force the next oscillation into a somewhat different path.

Second—An arc impelled by extremely high voltage and with considerable power behind is in continuous and very rapid eddying motion, flaring upward due to the upward draught of heated air. It never extinguishes itself, but frequently appears to jump across space by what seems to be bifurcation.

For comparison there is shown in photographs Nos. 11 and 12 a (powerless) oscillating discharge of very high frequency, about 150,000 cycles per second.

The terminals are the same as in the previous photographs, the striking distance is 9 inches (corresponding at low frequency to about 90,000 volts).

Photograph No. 11 shows an exposure of 1/10 second and photograph No. 12 a three-second exposure.

As may be seen in this discharge no arc follows the spark, but every set of oscillations gives a separate and distinct spark, although with long exposure a noticeable upward flare of the successive sparks is shown. The sparks show the same character as the starting spark of the power discharge in the previous photographs, that is, an erratic zigzag course. The individual oscillations of each discharge cannot be distinguished in the photograph, but each spark corresponds to a complete set of oscillations as produced by one condenser discharge, that is, one-half wave of the alternating supply current.

These sparks are produced by an oscillating condenser discharge. By an open magnetic circuit transformer having a ratio of turns of 1 to 300 the 125 cycle alternating supply current is stepped up in voltage and charges a mica condenser of such a capacity as to give nearly complete resonance, as shown by the rise of the ratio of transformation to about 1 to 700. This condenser discharges at about 20,000 volts over a series of seven small spark gaps through the primary of a Thomson transformer, whose secondary connects to the terminals of the disruptive discharge. The Thomson transformer consists of an external primary of a small number of turns and an internal secondary of a larger number of turns, both submerged in oil, but without iron core.

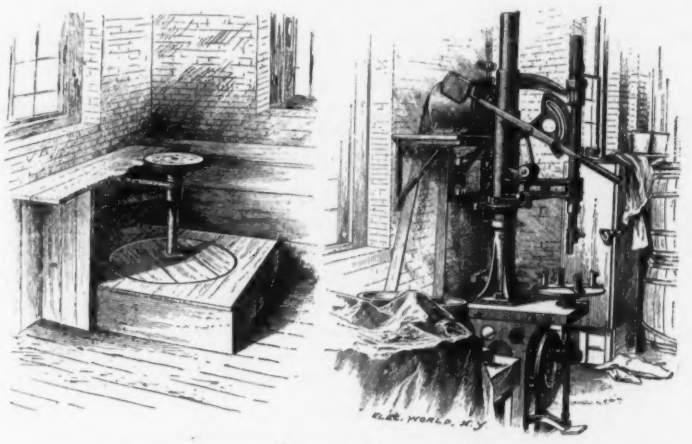
From the inductance and capacity of the discharge circuit an approximate frequency of oscillation of 150,000 cycles per second is calculated. The total input in the step up transformer is about 1 kilowatt, of which only a small part appears in the disruptive discharge.

This discharge seems to be harmless. To try the physiological effect of the powerful discharges in photographs 1 to 10 would not be advisable.

The Potter's Wheel—Ancient and Modern.

An interesting comparison of the old and the new is given in a recent number of "The Iron Age," to whom credit is due for the following description and illustration:

How old the potter's wheel is no man knows. Pictures in Egypt indicate its employment at least 6000 years ago. It then consisted merely of a round disc pivoted so that it could be turned by hand. Illustrations during the reign of the Ptolemys show a second disc, placed on the spindle near the floor, so that the operator could turn



ANCIENT AND MODERN POTTER'S WHEELS.

the wheel with his foot on this disc, leaving both hands to manipulate the clay.

At the works of the General Electric Company, at Schenectady, N. Y., are two potter's wheels, located within a few feet of each other. These represent the oldest and the latest types, and are both in use. The old form is twirled with the foot on the lower disc, the potter shaping the clay with his hands. The other wheel is furnished with a friction disc for changing speed, and with attachments for shaping the article mechanically. Secured to the top of the stand is a column, the upper portion of which carries a bracket, which may be rotated about the column. On the bracket is a segmental gear fitted with a counter-weighted lever and engaging with a rack on the tool holder.

The contrast between the old and the new is made more pronounced by the fact that the latter is driven by an electric motor. Here may be found almost the most primitive machine known working beside a machine for the same purpose provided with all the conveniences the present age can suggest.

The Successor of Prof. Galileo Ferraris.

Prof. Luigi Lombardi has been appointed Professor of Technical Physics at the Industrial Museum of Turin to fill the chair which was left vacant by the death of Prof. Galileo Ferraris.

The Precise Comparison of Very Small Resistances.

BY SAMUEL SHELDON.

The very accurate determination of electrical resistance of as small a magnitude as the hundred thousandth, or even the one-millionth of an ohm, is a problem which presents itself quite frequently of late in a testing laboratory. Such resistances may be small samples of material whose electrical conductivity it is desired to determine, they may be small standard resistances to be employed in the precise measurement of heavy currents by the potentiometer method, or they may be small shunt resistances to be used in connection with standard milli-voltmeters as station switchboard ammeters for heavy currents.

Such small resistances cannot be precisely measured unless they be of fairly large current carrying capacity. A sensitive D'Arsonval galvanometer of 1000 ohms resistance gives a positively noticeable deflection when a current of 0.000000001 ampere passes through it, or, what is equivalent, when one millionth of a volt is impressed

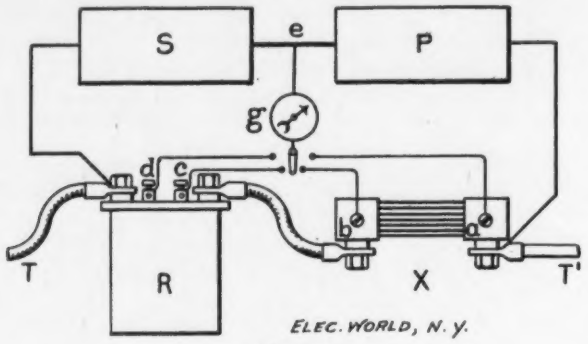


FIG. 1.

upon its terminals. For a resistance of a millionth of an ohm to be determined to one-tenth of a per cent. of its value by means of such a galvanometer requires that the resistance be traversed by at least 1000 amperes.

None of the classical methods of measuring low resistances are exactly suited to these determinations, especially if the magnitude of the unknown resistance differs much from that of the standard of comparison.

The method employed by Matthiessen and Hockin for comparing the relative conductivities of various alloys and metals, where wires of the two metals are connected in series and where potential points on these wires are balanced against corresponding equipotential points on a slide wire, the latter being connected in shunt to the first two wires, is not applicable, even when for one of the compared wires is substituted a standard branch low resistance of the Reichsanstalt pattern. The thermal currents arising from the friction of the slider on the slide wire are of such a magnitude as to render an exact balance impossible.

Thermal currents also prohibit the use of that form of the Thomson double bridge which employs a slide wire. In any form of this double bridge there is the further objection that current must be taken from the potential point terminals. In such cases one cannot by any means be sure that there is not a distortion of the flow lines which would give different values to the resistance according to the amount of current taken from these terminals.

Differential galvanometer methods are beyond consideration for use in many laboratories. Sensitive ones of the D'Arsonval type are not upon the market, and those which depend upon the earth's field for directive action are vexatious and unsatisfactory to work with.

There seems to be prevalent a misconception that the exquisite method of Carey-Foster, which yields such fine results when resistances of about 1 ohm are to be compared, will yield similarly good results when "inverted," i. e., when the slide wire becomes the unknown resistance. The fact that, when used in the ordinary manner, two resistances can be compared to within 0.01 per cent. of their values does not warrant us in assuming that, by inverting the process, we can determine the resistance of the wire to the same degree of accuracy. In ordinary practice the bridge wire has a resistance equal to about 0.01 that of the resistances to be compared. To determine, by means of the inverted bridge, the resistance of the bridge wire to an accuracy of 0.1 per cent. requires that the main resistances be adjusted to 0.001 per cent. This accuracy of adjustment in the case of small resistances is impossible of attainment. There are other objections to the method also.

The method outlined below has been used with great success at the Polytechnic Institute, and was developed by two students of last year's class, viz.: Messrs. Alfred E. Muller and Herman Wallau. The unknown resistance, X, Figure 1, which may be assumed to be supplied with branch potential points a b, is connected by heavy conductors in series with a standard branch resistance R, of the Reichsanstalt pattern having potential points c d. From the two free terminals T T', of these resistances are shunted two 10,000 ohm resistance boxes S P, adjusted to the same normal temperature and wound with wire of the same or negligable temperature coefficient, and connected in series. From the point of connection e, between the two boxes connection is made to one terminal of the galvanometer, g, the other terminal being connected successively with the potential points a b c and d. At the outset all the plugs are removed from the box S, and all are in place in the box P. After connecting T and T' with a source of heavy current, plugs are transferred from one box to the corresponding holes in the other box (this keeps the total resistance in the two boxes constant) until no deflection is observed in the galvanometer. This operation is repeated for each of the potential points a b c and d. Representing the resistances in the box S on the occasion of each of these balances by S_a S_b S_c and S_d respectively, we have the following expression for the value of the unknown resistance:

$$X = \frac{S_a - S_b}{S_c - S_d} R.$$

This method serves also to determine the resistance of a storage cell when the terminals T and T' are connected to a source of alternating currents, and when a telephone is substituted for the galvanometer. It is probable that by employing an electro-dynamometer instead of the galvanometer, whose fixed coil was connected to the main circuit before it reached the terminal T, according to the method recently advocated by Professor Rowland, the resistance of an accumulator could be determined with extreme accuracy.

Fig. 2 represents an instrument for measuring low resistances which is now under construction at the institute. Two standards of

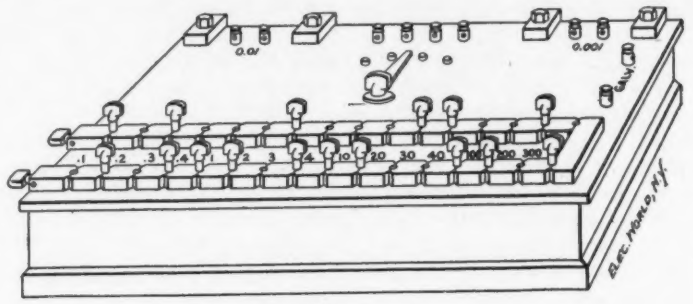


FIG. 2.

0.01 and 0.001 ohm and two resistance boxes are contained in one box, which has, in addition, potential point terminals and a switch mounted upon it.

Water Power Developments in Montana.

Two new hydraulic plants, from which power will be transmitted electrically, were described before the recent meeting of the Montana Society of Civil Engineers. The first is that of the Helena Water & Electric Power Company, at Canyon Ferry, on the Missouri River. Four sets of "American Special" turbine wheels, capable of delivering 1000 horse-power each, are now in place, beside two smaller turbines for running the exciters. Another plant, which will transmit power 28 miles to Butte, is being built by the Montana Power Company, on the Big Hole River. A crib-work dam, 500 feet long, 100 feet wide at its base and 56 feet high at the spillway crest, will be built and filled with rock, the up-stream face being finished with a concrete plank sheathed wall. A flume 15 feet wide and 28 feet high carries the water to steel penstocks 6 feet 6 inches in diameter, which lead to the wheels. There will be four special wheels made by the James Leffel & Co., 61 inches in diameter, and capable of generating 1200 horse-power each with a 60 foot head. These wheels will be coupled direct to alternating current generators. One thousand-hp engines will probably also be eventually installed in such a way that they can be directly coupled at any time to the main shafts for the generation of supplemental power at times of low water. Two 7-ton cranes will be installed to work together in the handling of the machinery.

London Electric Light Stations—I.

BY HERBERT C. GUNTON.

THE electric light stations of London offer a most interesting field for investigation, including as they do almost every system which the advocates of high tension, low tension and the combination of the two have been able to devise. As a matter of fact, the purely high tension and low tension men have now practically ceased to exist, since it is universally recognized that the system employed must necessarily be governed by the surrounding conditions. The blending in practice of methods widely differing in character is not only apparent in the general design of a system, but also in the very details thereof; the vexed question for instance of the old-fashioned Lancashire boiler as opposed to the water-tube boiler for central station work is being solved by the combination of the two types, the former being installed on account of its properties of steadiness and reserve, and the latter because of its adaptability for taking the central station over the peak of its load curve by virtue of its rapid steam raising qualities. Again, one finds the alternate current stations using rectifiers for arc lighting and for charging the accumulators of electric cabs, while the so-called low-tension station is extending its sphere of usefulness to a quite unforeseen extent by means of three-wire systems for 220-volt lamps and accumulator and transformer sub-stations. Finally, there is the station containing high and low tension plant linked together by the flexible connection afforded by the motor transformer, which enables an excess of power on one side to be transferred to the other side of the station. Refinements in matter of detail have lately been carried to a very elaborate extent, and one is inclined to think that central station engineers are often at fault in seeking a slight increase in efficiency which is often more than balanced by a too great increase in the capital expenditure; in fact, there are already signs of a reaction taking place, marked by a tendency to use the most simple and effective arrangement of plant.

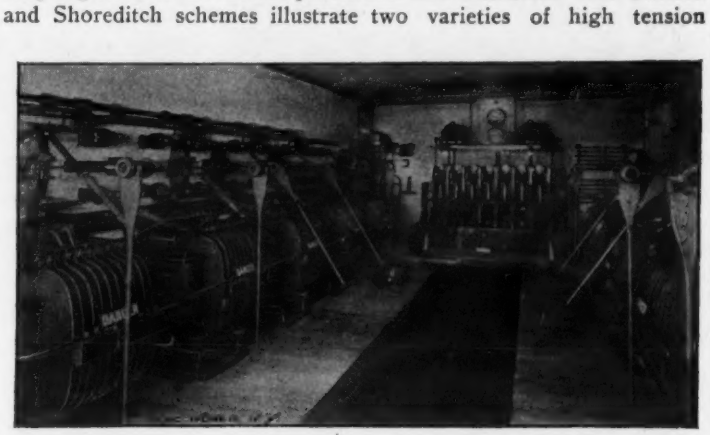
The best methods to employ in the case of street lighting, the utilization of refuse destructors for steam raising purposes, and the possibility of a combined lighting and traction station are among the problems whch are at present exercising the minds of the central station engineers in London, and, of course, elsewhere. With regard to the first of these, in the case of the alternate current stations the use of rectifiers seems to offer the most advantages, though rectifiers are admittedly rather uncertain, owing to a liability which the synchronous motors have of getting out of step. The employment of separate units, which are necessarily of comparatively small size, for dealing with public arc lighting, is regarded with disfavor, as it is bound to be accompanied by a loss of efficiency, both in floor space and in steam consumption. The combination scheme, consisting of arc lamps supplied from high tension circuits, and mounted on the same poles with and supplemented by incandescent lamps fed by the low tension mains, seems to be a safe and reliable way of dealing with this question.

The successful combination of dust destructors with electrical generating stations has yet to be proved. A great deal depends on the class of refuse obtainable, the amount of shavings and other combustible materials being much greater in some districts than others, and this no doubt accounts for the conflicting evidence from different stations. For example, the Shoreditch vestry has made a fairly promising start, while in the case of the St. Pancras vestry the method of working in conjunction with the destructor cells has been abandoned altogether. The number of boilers required when heated from the gases from the destructor cells is much larger than the number required when fired with coal, and it seems extremely unlikely that the amount of refuse available in any district will be sufficient in itself to furnish enough power for the lighting of that district.

As far as the writer is aware, instances of combined electric lighting and traction stations are few and far between, and although the problem is receiving very earnest consideration in England, the difficulties, both technical and financial, are very obvious. The supply of electricity for lighting purposes in London is not monopolized by a single company to the extent which it is in the chief American towns. When comparing the cost per unit sold with the corresponding figures in the case of the American companies, it must be remembered that the London engineers have to pay as much as 18s. 6d. per ton for coal of the best quality, and 8d. per 1000 cubic feet for water from the town mains.

It is naturally somewhat difficult to trace the origin of electric lighting in London, but according to Mr. Robert Hammond, in a résumé of twenty-five years' development in central stations, the first lighting station was erected in 1878 by the Metropolitan Board of Works, in order to illuminate the Thames embankment by means of Jablochkoff candles, this being before the incandescent lamp was perfected. Numerous companies have been formed since 1888, and started operations in the heart of the metropolis. Speaking generally, while the electric lighting of the more central parts of London is in the hands of private companies, whose systems overlap to a considerable extent, the less central districts are being supplied one by one by the municipal authorities of the different parishes, of which St. Pancras vestry was the pioneer, building its works in 1891.

The writer has chosen for analysis a few of the most important and representative systems, which he considers should be interesting as illustrating the methods of operation and the plant employed by London electrical engineers, who rightly pride themselves on the complete and efficient equipment of their generating stations. The London Electric Supply Corporation represents one of the pioneer undertakings, and one which was originally intended to provide the whole of London with electric light by means of extra high tension alternating current transmission, and which, although forestalled in this ambitious scheme by many rival concerns, is still extending its area of supply. The Islington vestry installation represents one of the most modern alternate current systems. The St. Pancras vestry plant is an example of an old low tension system adapting itself to modern requirements and extension. The Chelsea and Shoreditch schemes illustrate two varieties of high tension



SUB-STATION TRANSFORMERS, LONDON ELECTRIC SUPPLY CORPORATION.

continuous current transmission and low tension distribution, a system which is finding its way into many of the most modern undertakings.

THE LONDON ELECTRIC SUPPLY CORPORATION.

The system of the London Electric Supply Corporation consists of the Deptford central station and four distributing sub-stations, to which alternating current is transmitted over a distance of about 6 miles by concentric cables at 10,000 volts pressure. The Deptford station is situated on the banks of the Thames, near Greenwich, and was designed with a view to successfully meet the demands of future extensions, and one cannot help being struck by the wonderful foresight exhibited in every detail. Coal is conveyed to the station by barges from which it is hoisted by a steam crane and is then conveyed on the rails to the boiler room, 1000 tons being stacked in the yard as a reserve. The Thames water, after being passed through a filter bed, is used for condensing purposes, but owing to its corrosive properties it was found to be quite impossible to use it for feed water, the necessary supply for this purpose being taken from artesian wells.

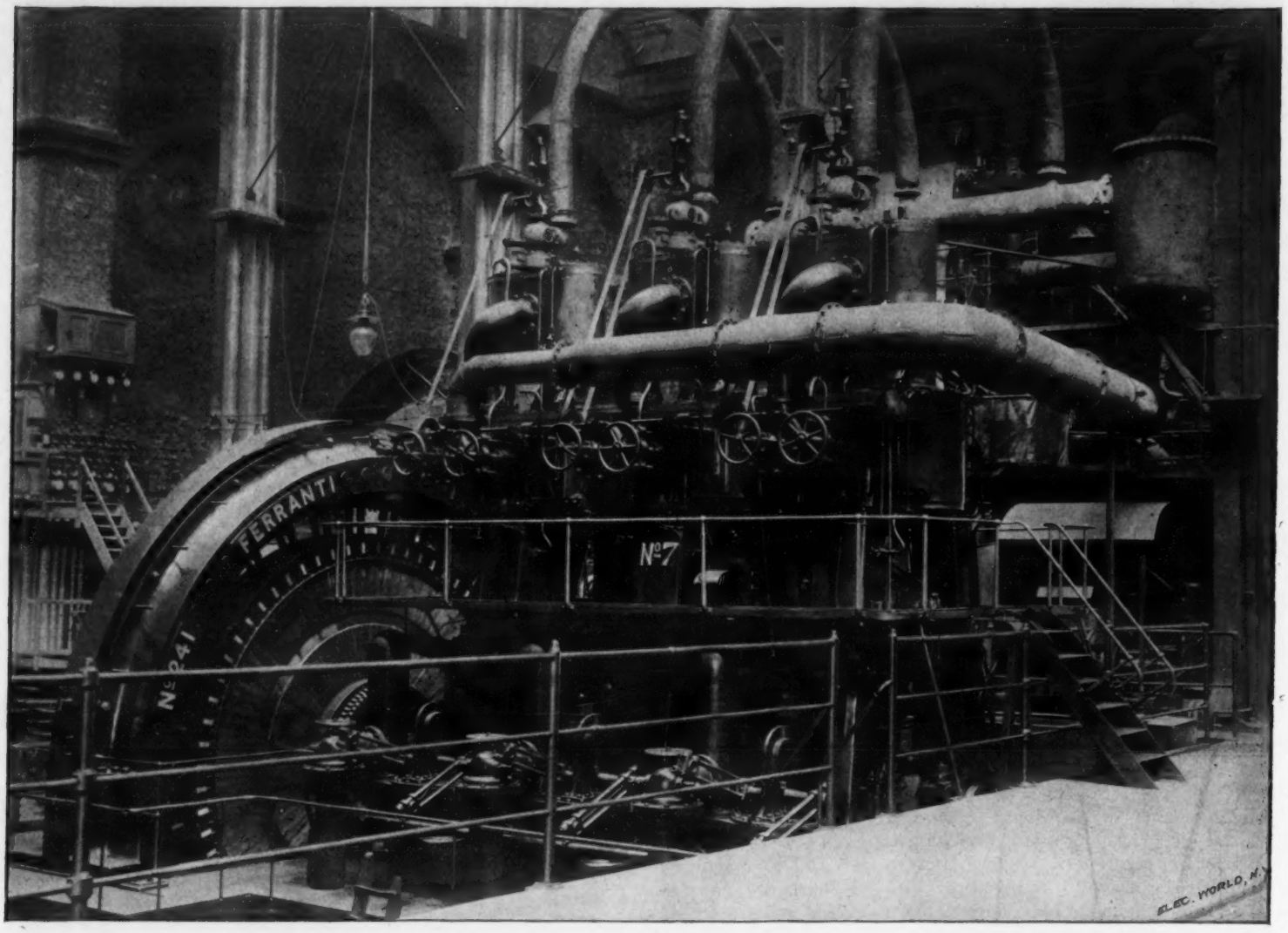
The boiler room is built to accommodate two tiers of boilers, the lower tier already installed consisting of twenty-four Babcock & Wilcox boilers of 500 horse-power each, which supply steam at a

pressure of 150 pounds. At each end of the boiler room are an economizer and a main stack, the latter being divided into four separate compartments. The boilers are stoked by hand and can be supplied with forced draught when necessary. A special feature of the distribution of steam is the multiple-pipe steam main, designed with a view to decreasing the danger and the disastrous effects of an explosion. The increase in the cooling surface, due to the number of tubes, is not serious when efficiently lagged, while the increased flexibility of a bend is quoted as an additional advantage.

Passing on to the engine room the plant installed consists of seven sets which present a very interesting object lesson, illustrating the comparative adaptability of several arrangements of engines driving alternators for running in parallel. The original sets installed in 1887 consist of two horizontal tandem compound Corliss engines of 700 horse-power, made by Messrs. Hicks, Hargreaves & Co., each of which drives by means of seventeen ropes a Ferranti alternator of 625 horse-power, supplying current at 2400 volts, the exciters for these machines being rope driven from the alternator shaft. The light load on Sundays and the early hours of the morning is taken care of by two 350-hp sets. Two larger sets consist of 1500-hp vertical cross-compound Corliss engines, also supplied by Messrs. Hicks, Hargreaves & Co., having cylinders 28 inches and 56 inches diameter, by 48 inches stroke, and each driving by means of forty ropes (from a flywheel placed between the high and low pressure cylinders) a Ferranti alternator of 1250 horse-power supplying current direct at 10,000 volts pressure. The most recent addition to the engine room plant, however, consists of a vertical tri-compound engine, with three cranks, set at thirds, made by Messrs. Plenty, of Newbury, driving direct a Ferranti alternator with a capacity of 1000 kilowatts at 10,000 volts. This engine is readily divisible and can be run as a one, two, or three-crank engine, if necessary. The high-pressure cylinders are 16 inches, and the low-pressure 27 inches diameter, with a common stroke of 26 inches. Joy's valve gear is employed, and is controlled by hydraulic pressure. The exhaust steam is passed either direct into the atmosphere or into a condenser worked from the back of the engine. The output of the alternator is 100 amperes at 10,000 volts when running at 156 r. p. m., the periodicity common of course to all machines in the station being 83 cycles per second.

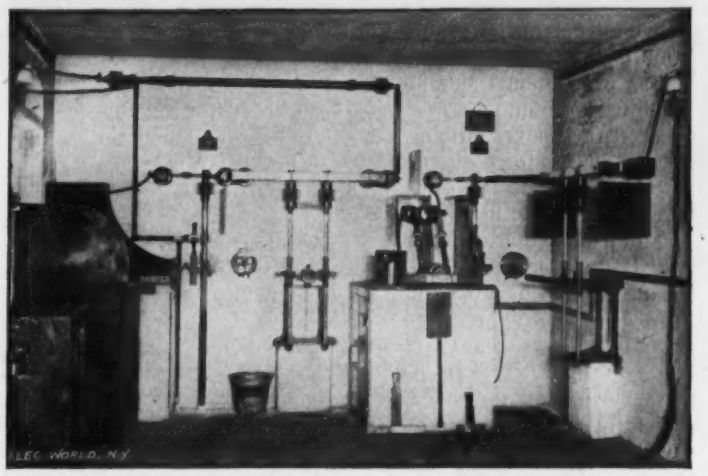
The construction of the Ferranti alternator has been too recently described in the pages of The Electrical World to warrant a detailed analysis, but the following points in connection with this particular machine may be of interest. The total weight of the alternator is about 80 tons, of which 26 tons are in the flywheel armature, and the over-all dimensions are 24 feet x 12½ feet x 14 feet high. There are 64 field magnet poles on each side of the armature which contains 128 coils, and to prevent sparking across from the armature to the field poles, at the high pressure of 10,000 volts, the latter are enclosed in micanite shields. The two halves of the field magnet frame can be opened out in order to render the machine accessible for inspection, this being accomplished by separating screws driven by an electric motor. The exciter plant for the whole station consists, in addition to the two machines previously mentioned, of seven direct driven sets, by W. H. Allen. The switchboard is placed on a gallery from which a commanding view of the station is obtained, and one is struck by the simple, yet thoroughly safe, method of dealing with the currents. The main switches are placed high up on the wall and are controlled by means of levers worked by long wooden handles, a quick spring break of 3 feet 6 inches being obtained, which is amply long enough to prevent the possibility of serious arcing. The pressure is measured by Cardew voltmeters connected across the secondaries of small pilot transformers.

From the Deptford station the current is conveyed by four concentric trunk mains to the distributing stations, the outer conductors being earthed at both ends of the transmission line. Provision is

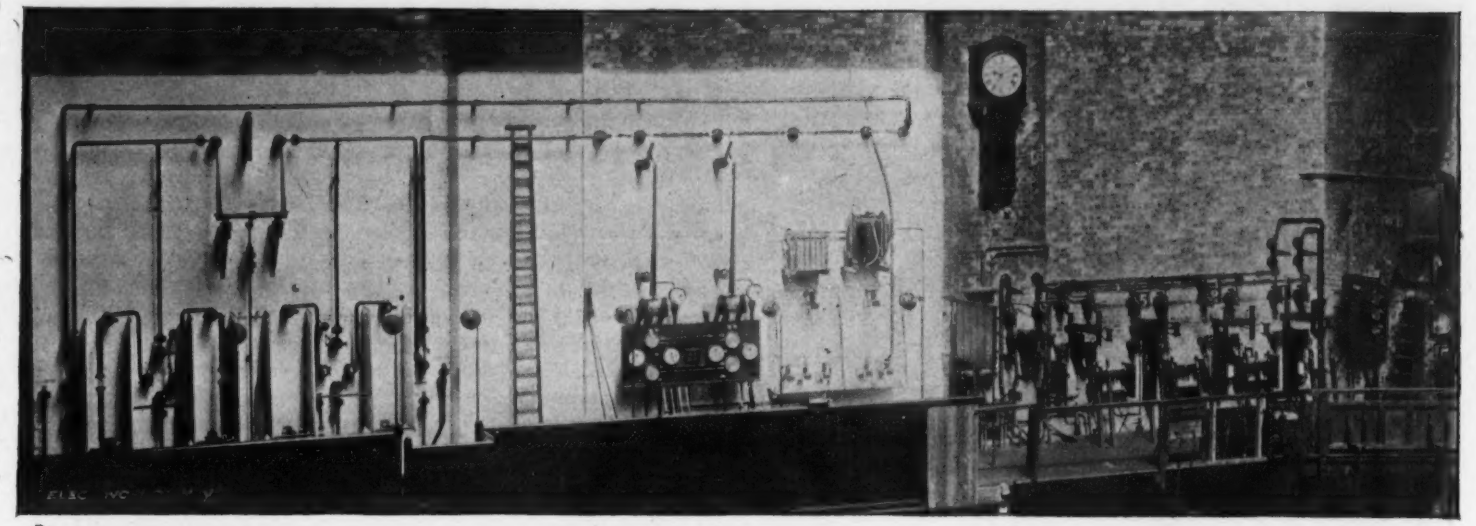


1000-kw Generating Set, Deptford Station.

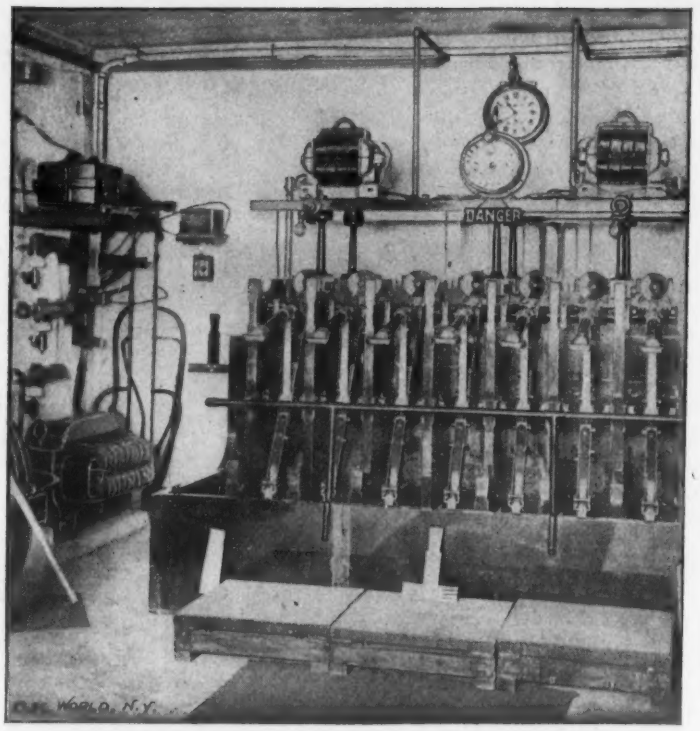
made at intermediate points for cross connecting these four trunk mains, and the chances of a total break-down are still further eliminated by the interconnection of the sub-stations. The illustrations give a good idea of the Trafalgar sub-station. The high tension mains enter at one end of the chamber and supply bus bars running down each side to which are connected ten 150-hp transformers, which reduce the pressure to 2400 volts. At the other end of the chamber is the 2400-volt feeder board from which the distributing network is supplied, the final reduction to 100 volts being effected on the consumers' premises, or in street transformer chambers. The charge which the company makes to its customers is 6d. per unit, with a sliding scale down to 4d. per unit, based on the following consumptions. For a consumption per 8-cp lamp exceeding 35 units per annum the rate is 5¾d., while for 50 units per annum it is reduced to 5d.* Current for cooking, heating, and power is supplied at 3d. per unit. Charges are also made for the rental of transformers, fuses, switches, etc., at the rate of £1 10s. per annum for capacity up to twenty-five 16-cp lights to £8 per annum for capacity up to 200 lights. Great watchfulness is necessary on the part of the central station staff, as the load curve rises toward evening by leaps and bounds, several large places of entertainment being connected to the mains. A recent addition to the load of the station is afforded by the demand for current for accumulator charging purposes by the London Electric Cab Company.



TRAFALGAR SUB-STATION.



SWITCHBOARD, DEPTFORD STATION.



TRAFALGAR SUB-STATION.

*An alternative charge made to suit larger consumers is at the rate of 6d. for the first 4000 units, all units in excess being charged at 4d.

Telegraph Service in Mexico.

Under date of Nuevo Laredo, Mexico, February 10, 1898, United States Consul-General Donnelly says:

"An interesting phase of Government ownership of public utilities is being presented in Mexico, where the Government operates a telegraph line of its own in competition with the lines of the several railroads. Advocates of Government ownership would doubtless expect the Government service to be the cheapest and best. Such, however, is not the case. The railroads gives the promptest service and generally a lower rate. The following table shows the Government and railroad telegraph rates on ten words from Nuevo Laredo to the cities named:

Nuevo Laredo to—	Government rate.	Railroad rate.
Monterey	$0.40	$0.26
Saltillo	.60	.51
San Luis Potosi	1.20	1.16
Mexico City	1.60	1.61

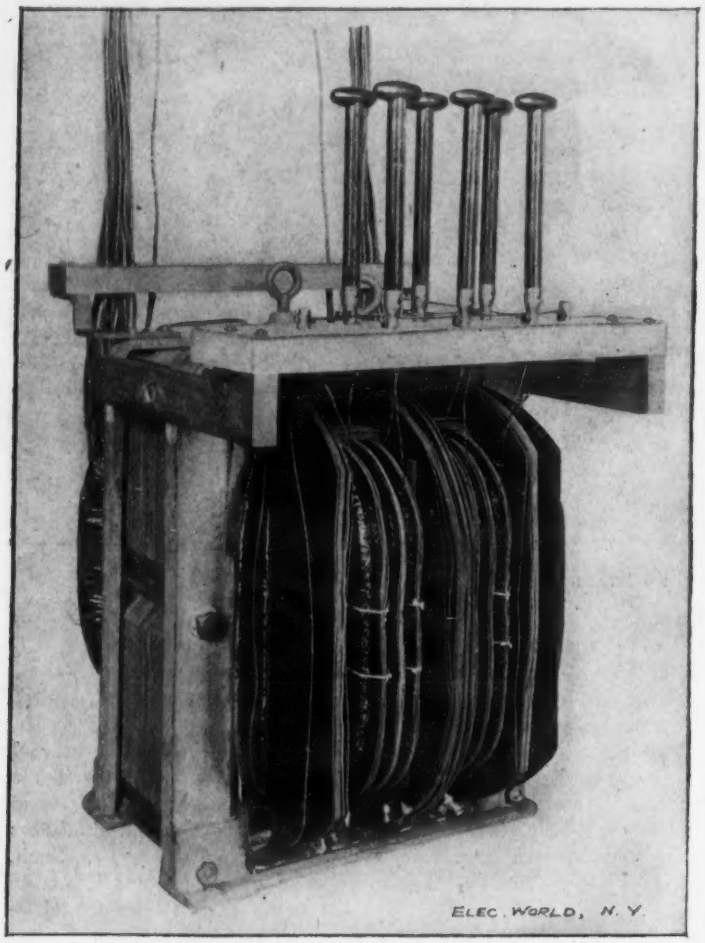
"As a natural consequence, the railroads have done the great bulk of telegraph business, both foreign and domestic."

Consul-General Donnelly, however, states that by a recent arrangement entered into by the Government with the Western Union Telegraph Company, of the United States, the latter company cedes to the Government the sole right to that company's Mexican business, and the Western Union, in return, obtains the business of the federal telegraph line. The Government has also issued an order prohibiting the railroads from handling any international messages. The effect of this will probably be to deprive the railroads of considerable business, and to give the Western Union Company control of the international telegraph service.

A 100,000-Volt Testing Set.

BY C. E. SKINNER.

In high potential working the tendency to break down the insulation of the system increases more rapidly than the potentials used, just as in running trains at high speeds the number of chances of wrecking the train increases faster than the speed. Phenomena which manifest themselves little or not at all in low potential working may become sources of positive danger to the life of the apparatus with higher potentials. In order to successfully overcome these added difficulties, due to high potentials, it is necessary to thoroughly understand the action of insulating materials and insulators under potential strains far beyond those actually to be used. The necessity for information of this kind has led to the development of a kind of test that has been extended to all classes of dynamo-electric machinery. This refers to the break-down or disruptive test with a high voltage transformer. In the early days of the art the measurement of the insulation resistance in megohms of a dynamo machine or transformer by means of a Wheatstone bridge was considered a sufficient test; now it is customary to test the actual break-down strength with an E. M. F. considerably greater than the apparatus



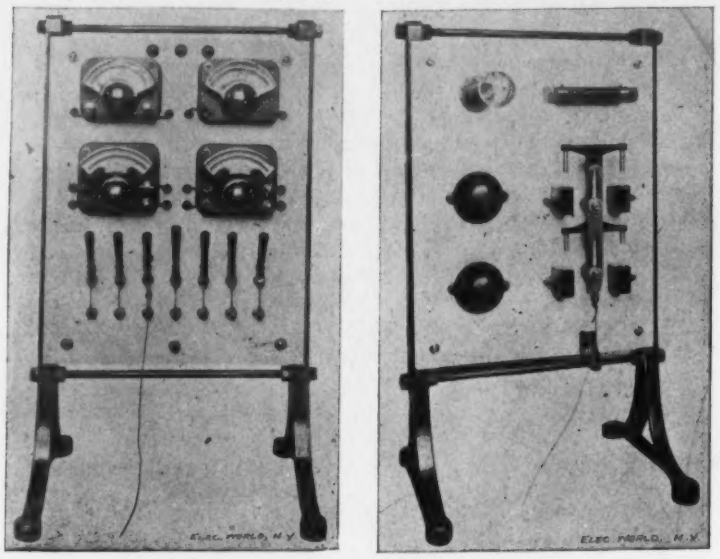
30-KW 100,000-VOLT TRANSFORMER, SHOWING CORE AND WINDINGS.

will ever receive in practice. Samples from all lots of raw material entering into the construction of the insulating parts of such machines are tested to determine their ultimate insulation strength. The insulation of transformers for long distance transmission work is tested many thousand volts higher than the normal E. M. F. of the transformer. Insulators for use on high potential lines are tested individually in the same way. Such tests compare with the physical tests on material which enters into the construction of a steam boiler and to the pressure test on the boiler when completed. Break-down tests show the working margin of the insulation.

The engineers in charge of the work of the Cataract Construction Company, at Niagara Falls, early realized the necessity for making most thorough tests on their insulating materials of all kinds and provided themselves with a testing transformer giving 40,000 volts maximum pressure. The output was small and the variations of the E. M. F. which could be obtained quite limited. To further carry out their insulation testing work they have recently ordered from the Westinghouse Electric & Manufacturing Company a testing outfit, by means of which tests may be made at any E. M. F. from 1200 volts to 100,000 volts. This outfit has been completed and is now being installed in the power house at Niagara Falls.

The general plan of the apparatus is as follows:

A 30-kw 100,000-volt transformer has its high tension winding divided into four equal sections, which may be connected in multiple for 25,000 volts, series multiple for 50,000 volts and in series for 100,000 volts, when the primary E. M. F. is 2200 volts. The primary winding is provided with loops brought out to a regulating dial, by

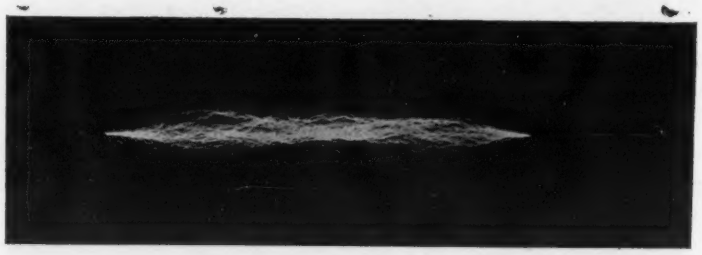


HIGH AND LOW TENSION SWITCHBOARDS.

means of which the voltage per turn of the transformer windings may be reduced to a little less than one-half the normal full voltage given above. This variation is made in steps of about 1 per cent. without interrupting the circuit. It is therefore possible to begin at about 12,000 volts and raise to 25,000 volts, then at 24,000 volts and raise to 50,000, and then at 48,000 volts and raise to 100,000 volts.

A second transformer is provided which is identical in general characteristics with the first, except that the voltage of the secondary or high tension winding is $^1/_{10}$ of the former permitting in the same way therefore variations from 1200 to 10,000 volts. Both transformers are operated from the same regulating dial and primary switching apparatus. Throw-over switches are provided for changing the dial from one transformer to the other. The total range of voltage is therefore from 1200 to 100,000 volts by steps of approximately 1 per cent. All measurements of current and voltage are made in the high tension or testing circuit.

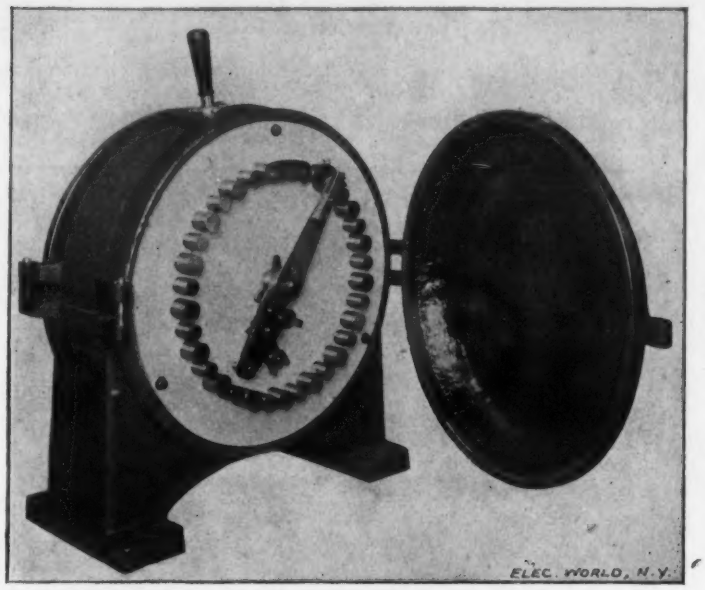
The apparatus is connected to the line by means of two plug switches of the blow-out type. In series with one of these is a 4-contact mercury safety switch, which is normally held open by



12-INCH DISCHARGE BETWEEN NEEDLE POINTS. 125,000 VOLTS, 7200 ALTERNATIONS.

means of a spiral spring. A fuse block of the "sneezer" pattern, so arranged that the fuses may be quickly and easily replaced, is in series with the mercury switch. A fault in the cable or insulator under test is indicated by the blowing of the fuse, which consists of a thin aluminum wire. The circuit is usually made and broken by the mercury switch, which has resistances connected between the contacts in such a way that no sudden rise of the E. M. F., due to making and breaking the circuit, is possible. The switches, fuse block and a pilot lamp are mounted on a portable marble panel, shown in the illustration.

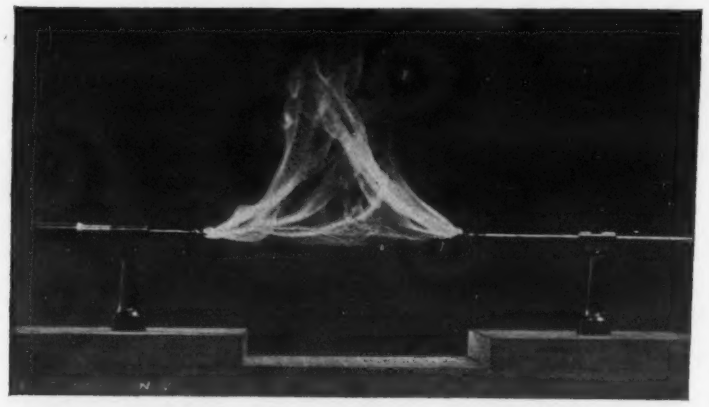
The loops for giving the variations of E. M. F. are brought out from the low tension coils in two groups, one at the beginning and the other at the end of the winding. The regulator has two similar dials, one group of leads being brought to each dial. The contact arms for both groups are operated by a single lever, shown at the top. This moves first one arm and then the other, in either direction, so as to raise or lower the E. M. F. as desired. This arrangement keeps the active winding symmetrical at all times.



VOLTAGE REGULATOR FOR 100,000-VOLT TESTING SET.

The transformers are of the standard self-cooling, oil insulated type manufactured by the Westinghouse Electric & Manufacturing Company. They are wound for 30 kilowatts at ¼, ½ and full voltage. In another illustration are shown the assembled coils of the 100,000-volt transformer after the iron is in place. The insulation of this transformer is identical with that used on all high tension transformers for long distance transmission work manufactured by the same company, the proportions only being changed to suit the voltage which is to be insulated. In both transformers the combination of high tension coils in multiple, series-multiple, and in series is made by means of switches under the oil of the transformers, the operating handles being brought through the case. These handles are shown on the top of the transformer. No part of the high tension circuit of either transformer is brought out of the oil except the two final testing terminals. For the 100,000-volt transformers these are brought through massive glass tubes held in place by the wooden cover of the containing case.

Both transformers were subjected to very severe running and insulation tests before leaving the factory. Some of the tests on the 100,000-volt transformer were as follows: It was run for some length of time open circuited at 150,000 volts. It was run at 125,000 volts with first one high tension terminal connected to the case and then the other. It was tested between high and low tension with 125,000 volts. No abnormal rise in the E. M. F., due to making and breaking the circuit, could be detected.



12-INCH ARC BETWEEN ¾-INCH SPHERES, 120,000 VOLTS, 7200 ALTERNATIONS.

Measuring instruments are provided in the high tension circuit for measuring volts, amperes and watts at all voltages up to a capacity of 30 kilowatts. The measuring instruments consist of one voltmeter, one ammeter and two wattmeters, with the necessary switches mounted on a marble panel similar to that used for the low tension switchboard. The instruments are direct reading, and are of the Thomson inclined-coil type. Each instrument has one terminal connected to the containing case to prevent false readings, due to static effects at the high E. M. Fs. used. The ammeter is used with an adjustable auto-transformer to give a range of full scale reading with 1/16, ¼, 1, 4, or 16 times the normal range of the instrument. The voltmeter and the shunt coils of the two wattmeters are in series with a german-silver resistance of about 1,300,000 ohms used as a multiplier, this resistance being so arranged that more or less may be cut in the circuit as desired. The resistance coils are non-inductively wound on glass plates, which are mounted in boxes so arranged that the entire length of the wire forming the resistance is exposed to the circulation of air. This is necessary, for at 100,000 volts even the very small current required to give full deflection on the voltmeter and wattmeters causes a $C^2 R$ loss in the resistance of more than 5 kilowatts. The error in the readings, due to increase in the resistance with temperature, is very small. The total length of wire used for winding this resistance is about 40 miles. The length of wire in the high tension coils of the 100,000-volt transformer is nearly 18 miles, so that the complete circuit through the high tension coils and through the resistance and instruments is about 60 miles.

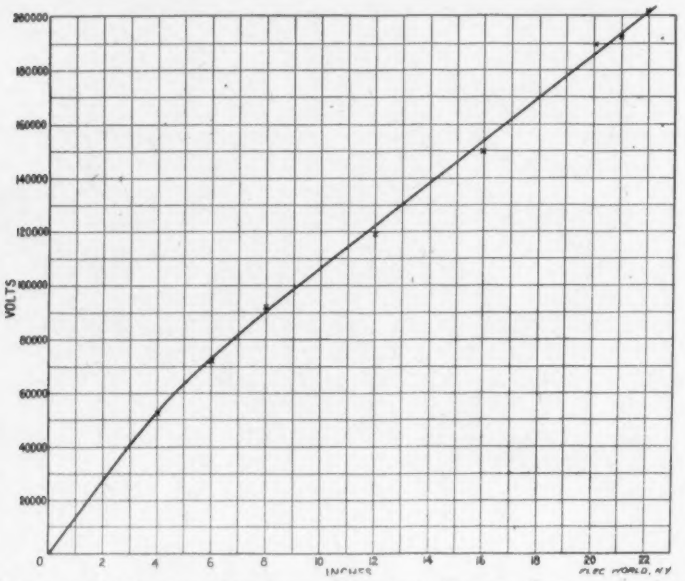
30-KW 100,000-VOLT TRANSFORMER COMPLETE.

As all measurements are made in the high tension circuits, errors due to drop in the converter with different loads are avoided. This method is especially necessary with inductive and capacity loads at the very high potentials.

Before leaving the factory the 100,000-volt transformer was run in series with a similar 100,000-volt transformer now in use in the experimental department of the works. Curves for the striking distance of E. M. Fs. up to 200,000 volts in air and in oil were obtained for different numbers of alternations and with different kinds

of armatures. For obtaining the striking distance curves in air a spark gap with a micrometer screw adjustment was used. Pin vises for holding needles and other kinds of terminals were fastened to the ends of the arms. In all these tests the spark gap was set to a given distance, then the E. M. F. raised by "cutting out" resistance from the field of the dynamo supplying the primary current until break-down occurred. The E. M. F. was read from a voltmeter connected to a special voltmeter winding around the core of one of the 100,000-volt transformers. The curve obtained for the striking distance between fine needle points at a frequency of 16,000 alts. per minute is shown herewith, the E. M. F. curve of the armature being practically a sine wave. The striking distance for 7200 and 3000 alts. was a little greater than the above, but there was less difference between the curves of different alternations at 75,000 volts and above than between some of the individual readings at the same number of alternations, taken at different times and under slightly varying conditions.

Above 75,000 volts all parts of the high tension circuit became more or less luminous before the break-down across the spark gap occurred. Beautiful violet colored brush discharges emanated from the needle points, becoming larger and more brilliant as the voltage increased. At 7200 alternations streams of intensely white sparks, accompanied by loud crackling sounds, passed between the needle points just before the E. M. F. became sufficient to short circuit the transformers across the air gap. These sparks were in appearance similar to the high frequency discharges obtained from a Tesla coil. The needle points were heated to redness, but not burned even after these discharges were continued for several seconds. Only a slight drop in the primary E. M. F. was noticed when this sparking occurred. A photograph of this phenomenom at an E. M. F. of 125,000 volts is shown. When the final break-down occurred the characteristic uprising arc was formed and the needle points were melted, throwing off scintillating particles of melted steel in every direction. At the higher voltages the striking distance between terminals made of three-quarter-inch spheres was not materially different from the striking distance between needle points. A photograph of the arc formed between three-quarter-inch spheres is also shown. Although no static discharge was noted when this photograph was taken a number of



Curve of Striking Distance Between Needle Points in Air, 16,000 Alternations. Sine E. M. F. Wave.

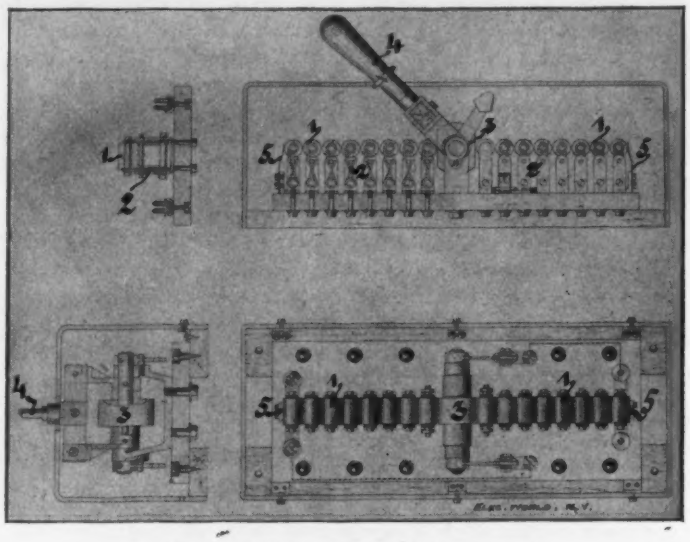
lines are distinctly shown in the photograph. A few of the lines show black against the arc as a background.

When the 1,300,000-ohm resistance was connected in circuit an arc could be held indefinitely, the amount of current flowing being about .075 amperes at 100,000 volts. The arc could not be drawn out much beyond the striking distance, 12 to 13 inches, at 100,000 volts. The peculiarity of this arc was that it had practically a uniform diameter of about one-half-inch throughout its entire length. The path taken was very tortuous, and it constantly changed in position. Fine static sparks passed between the points in addition to the arc when the length of the arc was less than the striking distance. The arc proper could be considerably deflected by an air blast, but the static sparks scarcely at all.

During the tests made up to 200,000 volts, the middle point where the two transformers were connected in series was connected to the transformer cases and also to ground. This brought a direct strain of 100,000 volts on the insulation of each of the transformers when full potential was used. No trouble with the insulation was experienced during this test. The operation of the completed testing set was most satisfactory in every respect.

A High-Tension Switch.

The principle of a multiple break between non-arcing contacts has been applied to switches for high tension circuits. This principle, which is well known in its application to the Wurts lightning ar-



Views of Multiple-Break Switch.

rester, depends upon the cooling and consequent extinguishing action of comparatively large metal bodies on the minute arcs drawn between them, and is further helped by the use of alloys not readily oxidizable when heated. To provide for proper renewal of the surfaces subject to the frequent use of switching work they are made up in the form of small cylinders which can be and are turned in such a way that the arc is always produced between new points. The contacts should also be arranged in such a way that they will break in very rapid succession, so that some one break will occur at the instant when the current is zero. The accompanying illustration shows a switch designed for this work by Chief Engineer H. Müller, of the Elektricitäts Actien Gesellschaft, late Schuckert & Co., of Nuremberg, Germany. This is designed for high tension alternating work and is not applicable to direct current circuits, the arcs produced by the latter acting in an entirely different manner. In this apparatus the path of the current is from one end of the switch to the other through the various rolls 1, in succession, these being mounted on springs 2.

The circuit is closed by turning down the lever 4, whereby the rolls are pressed outward and against each other by means of the flattened disc 3. These rolls are released when the lever is raised, thus causing the circuit to be broken. The end rolls are met by powerful flat springs, so that when the other rolls are pressed together these are but slightly displaced. As will be seen without further explanation all the rolls are caused to rotate when the circuit is opened or closed, and in consequence of this rotary motion imparted to the rolls these turn regularly after each operation of the switch, causing new surfaces to be brought into contact. Furthermore the rotary friction rubs off any oxide produced, and in consequence of these two circumstances the switch can be used for long periods without requiring repairs or renewal, which is a valuable quality in high pressure apparatus, owing to the physical danger involved in the interference with same.

The sparking produced by a switch constructed on this principle is so slight, even in breaking the circuit of high pressure currents up to 6000 volts, that the apparatus can safely be placed in the immediate neighborhood of instruments of any kind. For large currents it is advisable to shunt the multiple break device with an ordinary switch (as shown in the drawing) giving a path of lower resistance. The switch should, of course, be opened before the multiple break device. Even with 150 amperes and 2000 volts the switch performs its functions almost without sparking.

The Single-Phase Induction Motor.*

BY CHAS. PROTEUS STEINMETZ.

In the polyphase motor a number of secondary coils displaced in position from each other are acted upon by a number of primary coils displaced in position and excited by E. M. Fs. displaced in phase from each other by the same angle as the displacement of position of the coils.

In the single-phase induction motor a system of armature circuits is acted upon by one primary coil (or a system of primary coils connected in series or in parallel) excited by a single alternating current.

A number of secondary circuits displaced in position must be used so as to offer to the primary circuit a short-circuited secondary in any position of the armature. If only one secondary coil is used the motor is a synchronous induction motor and belongs to a different class, the reaction machines.

A single-phase induction motor will not start from rest, but when started in either direction will accelerate with increasing torque and approach synchronism.

When running at or very near synchronism, the magnetic field of the single-phase induction motor is identical with that of the polyphase motor. That is, the magnetic field has the same intensity in every direction, but is displaced in phase progressively, and can be represented by the theory of the rotating field. Thus in a turn wound at right angles to the primary winding of the single-phase induction motor, at synchronism an E. M. F. is induced equal to that induced in a turn of the primary winding, but differing therefrom by 90° in phase.

In a polyphase motor the magnetic flux in any direction is due to the resultant M. M. F. of primary and of secondary currents, in the same way as in a transformer. The same is the case in the direction of the axis of the exciting coil of the single-phase induction motor. In the direction at right angles to the axis of the exciting coil, however, the magnetic flux is due to the M. M. F. of the armature currents alone, no primary M. M. F. acting in this direction.

Consequently, while in the polyphase motor running light, that is doing no work whatever, the armature becomes currentless, and the primary currents are the only exciting currents of the motor, in the single-phase induction motor, even when running light, the armature still carries the exciting current of the magnetic flux in quadrature with the axis of the primary exciting coil. Since this flux has the same intensity as the flux in the direction of the axis of the primary exciting coil, the current in the armature of the single-phase induction motor running light, and therefore all the primary current corresponding thereto, has the same M. M. F., that is, the same intensity as the primary exciting current, and the total primary current of the single-phase induction motor running light is thus twice the exciting current; that is, it is the exciting current of the main magnetic flux plus the current inducing in the armature the exciting current of the cross magnetic flux. In the armature or secondary this exciting current is a current of twice the primary frequency.

Thus, if in a quarter-phase motor running light one phase is open circuited the current in the other phase doubles. If in the three-phase motor two phases are open circuited the current in the third phase trebles, since the resultant M. M. F. of a three-phase machine is 1.5 times that of one phase. In consequence hereof the total volt-ampere input of the motor remains the same, and at the same magnetic density, or the same impressed E. M. F., all induction motors, single-phase as well as polyphase, consume approximately the same volt-ampere input, and the same power input for excitation, and give the same distribution of magnetic flux.

Since the maximum output of a single-phase motor at the same impressed E. M. F. is considerably less than that of a polyphase motor, it follows that the relative exciting current in the single-phase motor must be larger.

The cause of this cross magnetization in the single-phase induction motor near synchronism is the fact that the induced armature currents lag 90° behind the induced magnetism, and are carried by the synchronous rotation 90° in space before reaching their maximum; thus they give the same magnetic effect as a quarter-phase E. M. F. impressed upon the primary system in quadrature position with the main coil, and can be eliminated by impressing a magnetizing quadrature E. M. F. upon an auxiliary motor circuit as is done in the monocyclic motor.

Below synchronism the induced armature currents are carried less than 90°, and thus the cross-magnetization due to them is correspondingly reduced, and becomes zero at standstill.

The torque of an induction motor is proportional to the armature energy currents times the intensity of magnetic flux in quadrature position thereto.

In the single-phase induction motor the armature energy currents can flow only coaxial with the primary coil, this being the only position in which corresponding primary currents exist. The magnetic flux in quadrature position is proportional to the component carried in quadrature, and the torque thus decreases much faster than in the polyphase motor with decreasing speed, and becomes zero at standstill. Since in the single-phase motor one primary only, but a multiplicity of secondary circuits, exists, all secondary circuits are to be considered as corresponding to the same primary circuit, and thus as the secondary impedance there is to be used the joint impedance of all secondary circuits.

In consequence hereof the resultant secondary impedance of a single-phase motor is less in comparison with the primary impedance than in the polyphase motor. Since the drop of speed under load depends upon the secondary resistance, in the single-phase induction motor the drop in speed at load is generally less than in the polyphase motor. This greater constancy of speed of the single-phase induction motor has led to the erroneous opinion that such a motor operates at synchronism, while in reality even at no load whatever it cannot approach perfect synchronism.

In general, no special motors are used for single-phase circuits, but polyphase motors are adapted thereto. An induction motor with one primary winding only could not be started by a phase-splitting device, and would necessarily be started by external means. A polyphase motor, as for instance a standard three-phase motor operating single phase, by having two of its terminals connected to the single-phase mains is just as satisfactory a single-phase motor as one built with one primary winding only. The only difference is that in the latter case a part of the circumference of the primary structure is left without winding, while in the polyphase motor this part contains windings also, which, however, are not used, or not effective when running as single-phase motor, but are necessary when starting by means of displaced E. M. Fs. Thus in a three-phase motor operating from single-phase mains, in starting the third terminal is connected to a phase-displacing device, giving to the motor the cross-magnetization in quadrature to the axis of the primary coil, which at speed is produced by the rotation of the induced secondary currents, and which is necessary for producing the torque by its actions upon the induced secondary energy currents.

Thus the investigation of the single-phase induction motor resolves itself into the investigation of the quarter-phase or three-phase, or in general polyphase motor operating on single-phase circuits.

In general it can be said that a fair polyphase motor makes a poor single-phase motor. A good polyphase motor makes a fair single-phase motor, and to get a good single-phase motor an exceedingly good polyphase motor is required.

The speed is much more constant in the single-phase induction motor than in the polyphase motor.

The maximum torque and output of the single-phase motor is somewhat greater than that of the three-phase motor per circuit. Hence, since the total torque and output of the three-phase motor is three times that per circuit, the single-phase motor at the same impressed E. M. F. gives less than half the output of the polyphase motor. This is the cause of the inferiority of the single-phase motor. With the same volt-ampere excitation, the same loss of energy in the iron, and somewhat over half the loss of energy in the copper, the output is reduced to less than one-half.

Obviously by operating the single-phase motors at higher voltage, or what means the same, rewinding them for a higher density, their output can be increased, but as discussed before, their constants are not changed thereby. Limiting the output by the heating of the motor, that is the loss of energy therein, the permissible rating of a motor on single-phase circuit is about from ⅔ to ¾ that of the same motor rewound for polyphase circuits. In this case, the magnetic density of the single-phase motor is from 25 to 30 per cent. higher: thus the exciting volt-amperes and the loss in the iron correspondingly higher, as represented by the constants of the motor.

The falling off of the torque and the output of the single-phase

* Extracts from a paper read before the American Institute of Electrical Engineers, New York, February 23, 1898.

motor with decreasing speed is much more abrupt than in the polyphase motor. Thus, while in the polyphase motor the insertion of resistance in the armature does not change the torque, but merely shifts all its values toward lower speeds, in the single-phase motor resistance in the armature not only shifts the values of torque toward lower speed, but also reduces the maximum obtainable values.

The torque curves of the single-phase motor have the same general character as those of the three-phase motor; a stable branch between synchronism and maximum torque and an unstable branch between maximum torque and standstill. The difference, however, is that all the single-phase torque curves slope toward zero at standstill, while the three-phase curves show considerable torque at standstill. With increase of armature resistance, the maximum torque point shifts toward lower speed, but at the same time decreases in the single-phase motor, while it remains the same in the three-phase motor. In the single-phase motor the maximum torque point is nearer synchronism, that is, the speed regulation is better.

In the single-phase motor a stable and an unstable branch of the torque curve always exist. In the polyphase motor the latter disappears beyond a certain secondary resistance.

Torque efficiency and apparent torque efficiency are different in so far as these quantities in polyphase motors approach finite values at standstill, while in single-phase motors their curves slope toward zero at standstill. The torque efficiency and apparent torque efficiency reach their maxima at higher speed or lesser slip on single-phase than on polyphase circuit, and are lower.

It is obvious herefrom that the single-phase induction motor, while quite fair in the range of speed above the maximum torque point, becomes very unsatisfactory below this point, or at lower speeds. Armature resistance in the single-phase induction motor brings the maximum torque point down to lower speeds. But since the maximum torque is lowered the more the speed is reduced at which it occurs, single-phase motors cannot be operated on rheostatic control for variable speeds as satisfactorily as polyphase motors, and armature resistance is thus used mostly only for starting the motor.

Since the torque of the single-phase motor falls off in any case with decreasing speed, the use of variable armature resistance in starting a single-phase motor is far more necessary than in polyphase motor. For instance, a good three-phase motor will carry one-third of full load from standstill up to synchronism with short-circuited low resistance armature, and practically full load from one-half speed. The same motor as single-phase motor will carry one-third load from one-fourth speed, or two-thirds load from one-half speed up to synchronism, only when the armature resistance is the most favorable.

At standstill the single-phase motor torque is zero, and thus some starting device, electrical or otherwise, is needed. This starting device, however, while it needs not to bring the motor up to full synchronism, as necessary with a single-phase synchronous motor, has to bring it up to some considerable speed, since only at about one-fourth speed the inherent torque of the single-phase induction motor becomes noticeable, and considerable only at about one-half speed. With short-circuited low resistance armature the starting device has to bring the motor up fairly close to synchronism.

Concatenation or tandem control of single-phase induction motors can be used, but the result is not as satisfactory as with polyphase motors, since the magnetic field of the single-phase motor becomes uniform only when approaching synchronism, and thus at half speed the E. M. F. induced in the secondary is pulsating in intensity.

The effect of the change of frequency and change of the number of poles, etc., is the same in the single-phase motor as in the polyphase motor.

As stated above, the single-phase induction motor at standstill has no starting torque, since the line of polarization due to the armature currents coincides with the axis of magnetic flux impressed by the primary circuit. Only when revolving is torque produced, due to the axis of armature polarization being shifted against the axis of magnetism by the rotation, until at or near synchronism it is in quadrature therewith, and the magnetic disposition is thus identical with that of the polyphase induction motor.

Leaving out of consideration starting by mechanical means, and starting by converting the motor into a series or shunt motor, that is, by passing the alternating current by means of commutator and brushes through both elements of the motor, as methods of starting single-phase motors there are left:

1. Shifting of the axis of armature or secondary polarization against the axis of inducing magnetism.

2. Shifting the axis of magnetism, that is producing a magnetic flux displaced in position from the flux inducing the armature currents.

The first method requires a secondary system which is unsymmetrical in regard to the primary, and thus, since the secondary is movable, requires means of changing the secondary circuit, that is commutator brushes short-circuiting secondary coils in the position of effective torque, and open-circuiting them in the position of opposing torque.

Thus this method leads to the repulsion motor, which is a commutator motor also.

With the commutatorless induction motor, or motor with permanently closed armature circuits, all starting devices consist in establishing an auxiliary magnetic flux in phase with the induced secondary currents in time, and in quadrature with the line of armature polarization in space; that is, they consist in producing a component of magnetic flux in quadrature in space with the primary magnetic flux inducing the armature currents and in phase with the latter; that is, in quadrature with the primary magnetic flux.

Thus all starting devices of the commutatorless single-phase induction motor consist in the production of a component of magnetic flux displaced from the axis of polarization of the induced or armature currents.

The infinite variety of arrangements proposed for this purpose can be grouped into three classes.

1. Phase-Splitting Devices.—The primary system is composed of two or more circuits displaced from each other in position, and combined with impedances of different inductance factors so as to produce a phase displacement between them.

When using two motor circuits, they can either be connected in series between the single-phase mains, and shunted with impedances of different inductance factors, as, for instance, a condensance and an inductance, or they can be connected in shunt between the single-phase mains, but in series with impedances of different inductance factor. Obviously the impedance used for displacing the phase of the exciting coils can either be external or internal, as represented by high-resistance winding in one coil, etc.

In this class belongs the use of the transformer as a phase-splitting device, by inserting a transformer primary in series to one motor circuit in the main line, and connecting the other motor circuit to the secondary of the transformer, or by feeding one of the motor circuits directly from the mains, and the other from the secondary of a transformer connected across the mains with its primary. In either case it is the internal impedance of the transformer which is combined with one of the motor circuits for displacing its phase, and thus this arrangement becomes most effective by using transformers of high internal impedance, that is, poor transformers.

2. Inductive Devices.—The motor is excited by the combination of two or more circuits which are in inductive relation to each other. This mutual induction between the motor circuits can either take place outside of the motor in a separate phase-splitting device, or in the motor proper.

In the first case the simplest form is the divided circuit whose branches are inductively related to each other by pasing around the same magnetic circuit external to the motor.

In the second case the simplest form is the combination of a primary exciting coil and a short-circuited secondary coil induced thereby on the primary member of the motor, or a secondary coil closed by an impedance.

3. Monocyclic Starting Device.—An essentially wattless E. M. F. of displaced phase is produced outside of the motor, and used to energize a cross-magnetic circuit of the motor, either directly by a special teaser coil on the motor, or indirectly by combining this wattless E. M. F. with the main E. M. F. and thereby deriving a system of E. M. Fs. of approximately three-phase or any other relation. In this case the primary system of the motor is supplied essentially by a polyphase system of E. M. F. with a single-phase flow of energy, a system which I have called "Monocyclic."

The torque of the single-phase induction motor (without starting device) is proportional to the product of main flux or magnetic flux produced by the primary impressed E. M. F. and the speed. Thus it is the same as in the polyphase motor at or very near synchronism, but falls off with decreasing speed and becomes zero at standstill.

To produce a starting torque, a device has to be used to impress an auxiliary magnetic flux upon the motor, in quadrature with the

main flux in time and in space, and the starting torque is proportional to this auxiliary or quadrature flux. During acceleration or at intermediate speeds, the torque of the motor is the resultant of the main torque, or torque produced by the primary main flux, and the auxiliary quadrature or starting influx. In general this resultant torque is not the sum of main and auxiliary torque, but less, due to the interaction between the motor and the starting device.

All the starting devices depend more or less upon the total admittance of the motor and its power factor. With increasing speed, however, the total admittance of the motor decreases and its power factor increases, and an auxiliary torque device suited for the admittance of the motor at standstill will not be suited any more for the changed admittance at speed.

The currents induced in the secondary by the main or primary magnetic flux are carried by the rotation of the motor more or less in quadrature position and thus produce the quadrature flux, giving the main torque, as discussed above.

This quadrature component of the main flux induces an E. M. F. in the auxiliary circuit of the starting device and thus changes the distribution of curents and E. M. Fs. in the starting device. The circuits of the starting device then contain besides the motor admittance and external admittance an active counter E. M. F., changing with the speed. Inversely the currents produced by the counter E. M. F. of the motor in the auxiliary circuits react upon the counter E. M. F., that is, upon the quadrature component of main flux and change it.

Thus during acceleration we have to consider:

1. The effect of the change of total motor admittance, and its power factor, upon the starting device.

2. The effect of the counter E. M. F. of the motor upon the starting device, and the effect of the starting device upon the counter E. M. F. of the motor.

The total motor admittance and its power factor change very much during acceleration in motors with short-circuited low resistance secondary. In such motors the admittance at rest is very large and the power factor low, and with increasing speed the admittance decreases and its power factor increases greatly. In motors with short-circuited high resistance secondary the admittance also decreases greatly during acceleration, but its power factor changes less, being already high at standstill. Thus the starting device will be affected less. Such motors, however, are inefficient at speed. In motors with variable secondary resistance the admittance and its power factor are maintained constant during acceleration by decreasing the resistance of the secondary circuit in correspondence with the increasing counter E. M. F. Hence in such motors the starting device is not thrown out of adjustment by the changing admittance during acceleration, and they are thus preferable.

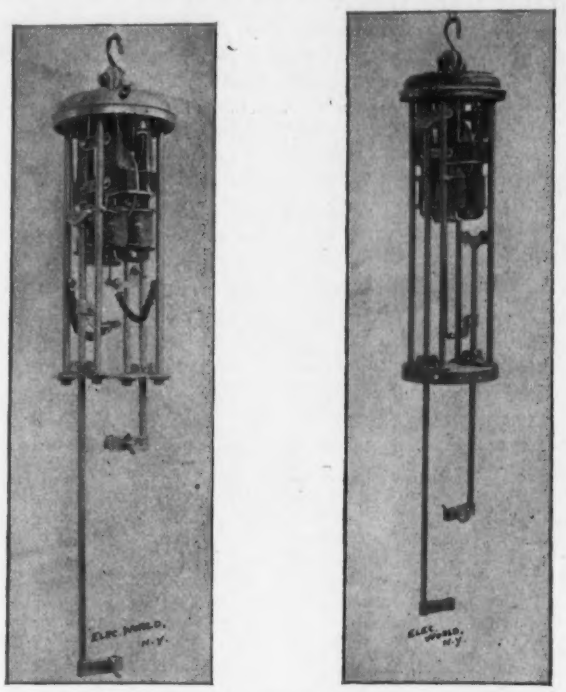
While any desired torque can be produced by the use of resistance and inductance and mutual induction as starting devices, the torque is necessarily far below that which can be produced in a polyphase motor with the same expenditure of volt-amperes or of watts, that is, the apparent torque efficiency and the torque efficiency are lower. A much better starting torque efficiency, and apparent torque efficiency, under circumstances almost as good, or better, as in a polyphase motor, can be produced by the use of capacity. Capacity, however, is generally only suitable for a sine wave of E. M. F. and most generators do not give a sine wave, and in general the use of a wave differing from sine shape is preferable for other reasons, while for the motors proper the wave shape is immaterial. Furthermore, when securing high starting torque by means of capacity, with the change of admittance during acceleration the conditions become unfavorable much faster than by the use of resistance, Inductance and mutual induction. Hence, while good starting torque can be produced by capacity, in general this torque is not maintained during acceleration up to the speed where the main torque of the motor is sufficient for further acceleration, and thus such a motor will start, but not run up to speed.

Polyphase Laboratory Plant at Cornell University.

A polyphase plant for experimental purposes is about to be installed in the physical laboratory of Cornell University. The plant will contain both two and three-phase apparatus, induction and synchronous motors, a rotary converter and apparatus for transformation from the two phase to the three-phase system and vice versa.

The Induction Motor as an Arc Regulator.

An alternating arc lamp regulator of most simple and ingenious design is that of the French instrument maker, Fabius Henrion, of Nancy, France. As shown in the accompanying illustration the carbons are held in carbon holders, both of which move when the lamp feeds, thus maintaining the arc at a fixed point. These carbon holders are supported by a ribbon passing over a small pulley. This pulley is mounted with a large metallic disc on a horizontal shaft, an alternating magnet in series with the arc being mounted on one side with its pole pieces embracing the edge of the disc, and a similar magnet in shunt with the arc on the other side, also embracing the disc. These pole pieces are properly fitted with shading coils, by which rotary fields are produced in such a manner that the series magnet tends to rotate the disc in one direction, and the shunt magnet tends to rotate it in the other. In normal running the two tendencies are exactly balanced, the shunt magnet predominating when the arc is too long and turning the disc in such a way as to feed the upper carbon down and pull the lower carbon up, and the



VIEWS OF INDUCTION MOTOR ARC REGULATOR.

series magnet predominating when the arc is too short, feeding the carbons respectively in the opposite directions. This simple device does away with all gear wheels, ratchets, escapements, pawls, clutches, springs, and all such troublesome devices, no special parts being necessary for striking the arc or for dropping the carbons together, when the current is switched off. The disc is carefully journaled, and the carbon holders are guided by rollers so that the mechanism is sensible to a variation of one-tenth of one volt across the carbons.

Aluminum as a By-Product of a Battery.

Judging from conversations with some experts on the subject of electro-chemistry, it appears that it is not generally known that a battery was invented quite a number of years ago which yielded metallic aluminum as a by-product. The following meagre notes, which were made some fifteen years ago, may therefore be of interest.

The primary battery is known as that of Lacassagne and Thiers, and appears therefore to be of French origin. A crucible, which forms the battery jar, contains chloride of sodium and an iron electrode; a porous cup placed in this contains chloride of aluminum and a carbon electrode. This is placed in a furnace, and is brought to the fusing point of the electrolytes, when it is said to yield quite a constant current, the by-product from which is metallic aluminum.

More detailed information of this curious battery does not seem to be available, but perhaps some readers of THE ELECTRICAL WORLD have experimented with it, and can enlighten those interested in the subject. As it has been known a number of years it is not unlikely that practical difficulties are involved in its use.

Separation of the Iron Losses of a Transformer.

BY PROF. H. S. CARHART.

The following elaboration of a method of separating the iron losses taking place in a transformer is based on the measurement of these combined losses at two frequencies. A series of measurements is made at each frequency for a number of different voltages. From these two series we may obtain several pairs of equations connecting together the hysteresis and eddy current losses, each pair being taken for the same value of the maximum instantaneous induction $\mathfrak{B}$ of the magnetic wave at the two frequencies. From each pair of equations may be obtained both the eddy current loss and the loss by hysteresis for the voltage corresponding.

To keep the magnetic induction constant, the E. M. F. E must be proportional to the frequency. This is evident from the general formula for the effective E. M. F., which is

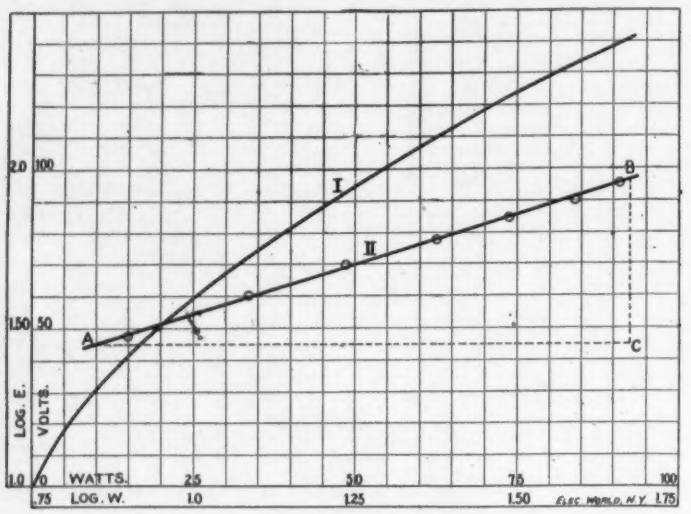
$$E \times 10^8 = \sqrt{2}\,\pi\, n\, A\, \mathfrak{B}\, N \text{ volts.}$$

where n is the frequency, A the cross section of the iron, $\mathfrak{B}$ the maximum induction, and N the number of turns of wire. If $\mathfrak{B}$ is constant, E is proportional to n.

If then W and W' are the total iron losses for the two frequencies n and n', both with the same value of $\mathfrak{B}$, we may write for the equations of these losses the following:

$$W = a\, n^2 + b\, n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$
$$W' = a\, n'^2 + b\, n' \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

These equations are written on the assumption that the eddy current loss is proportional to the square of the frequency. The loss by hysteresis is of course proportional to the first power of the frequency. The constants a and b are respectively the eddy current and hysteresis loss per cycle for the same value of the maximum induction $\mathfrak{B}$.



Plot of Transformer Losses.

If W' is the iron loss for an E. M. F. E', then the value of E for the same magnetic induction in the other series is $E'\, n/n'$. The corresponding watts W lost in the iron at the frequency n may be read from the curve representing the relation between volts and watts lost at that frequency.

The measurements below were made on a 2-kw Slattery transformer. The current was furnished by the small laboratory alternator, which I have described in another place. (*American Electrician*, November, 1897.) The following series of observations were taken:

Series A. Frequency, 154.7.		Series B. Frequency, 103.7.	
Volts.	Watts.	Volts.	Watts.
30	9.0	30	9.8
40	12.8	40	15.1
50	19.4	50	21.3
60	25.2	60	28.4
70	31.6	70	36.1
80	38.9	80	44.5
90	46.5	90	53.1
100	54.2	100	62.2
110	62.7		
120	71.5		
130	81.1		
140	91.5		

Curve I in the diagram expresses the relation between volts and watts for Series A. It is used to find by interpolation the watts corresponding to the voltages under A in the following table. These voltages are found, as already explained, by multiplying those of Series B by the ratio n/n'. In the present case this ratio is 1.491.

Series B.		Series A.	
Volts.	Watts.	Volts.	Watts.
30	9.8	44.73	16.0
40	15.1	59.64	24.7
50	21.3	74.55	34.75
60	28.4	89.46	45.75
70	36.1	104.37	57.7
80	44.5	119.28	70.6
90	53.1	134.19	84.75

By substitution in equations (1) and (2) we may now obtain seven pairs, viz.:

$$16 = \overline{154.7}^2\, a_1 + 154.7\, b_1$$
$$9.8 = \overline{103.7}^2\, a_1 + 103.7\, b_1 \ldots\ldots\ldots\ldots\ldots\ldots (1)$$
$$* \quad * \quad * \quad * \quad * \quad *$$
$$84.75 = \overline{154.7}^2\, a_7 + 154.7\, b_7$$
$$53.1 = \overline{103.7}^2\, a_7 + 103.7\, b_7 \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

The intermediate equations can be filled in from the table above. Solving these equations for the eddy current losses, we get the following for the frequency 103.7:

Eddy Loss.	Total Loss.	Hyster. Loss.	Volts.
1.9	9.8	7.9	30
2.9	15.1	12.2	40
4.09	21.3	17.21	50
4.66	28.4	23.74	60
5.29	36.1	30.81	70
5.81	44.5	38.69	80
7.63	53.1	45.47	90

We have thus separated the losses for the frequency 103.7; the same equations may be used to separate them for the frequency 154.7.

Since these seven pairs of equations involve different values of the magnetic induction $\mathfrak{B}$, they may evidently be employed to determine the exponent of $\mathfrak{B}$ in Steinmetz's formula for the hysteretic loss. For the same value of n the hysteretic loss in watts may be written $W = c\,\mathfrak{B}^x$, where c is a constant. Hence:

$$\log W = x \log \mathfrak{B} + \text{constant.}$$

But for the same frequency, $\mathfrak{B}$ is proportional to the volts E. Let $\mathfrak{B}$ equal $k\,E$. Then, since k is a constant,

$$\log W = x \log k + x \log E + \text{constant} = x \log E + \text{constant.}$$

The relation between the logarithms of W and E is evidently the equation of a straight line, and the desired exponent x is the tangent of the angle which this line makes with the axis of log E. The logarithms of the loss by hysteresis and of the corresponding volts of the last table are plotted in Curve II. of the diagram. The tangent of the angle $A\,B\,C$, measured in terms of the two scales on which the logarithms are plotted, is quite closely 1.6.

The method obviously gives better results when the measurements are made on a transformer having iron losses which can be read on the best part of the scale of the wattmeter. The small readings are not so reliable as the larger ones.

I have applied the same method to the small transformer described in The Electrical World, September 18, 1897. The plot of the logarithms gave the same result, viz., 1.6. This confirms Steinmetz's formula for the loss by hysteresis.

The Heilmann Locomotive.

An exact duplicate of the latest model of the Heilmann locomotive has just been finished, and is about to undergo a series of tests similar to those now being made on the original. This locomotive is gradually being tested under more and more severe conditions, the loads and speeds being increased. The most severe test so far reported is one at a speed of 47 miles an hour, with a load of about 250 tons.

Prize for an Electrical Invention.

The officers of the International Exhibition to be held in Turin, Italy, have offered a prize of 15,000 lire (about $3,000) for the best invention, apparatus, system or machine devised for the application of electricity to industrial purposes. The prize is in honor of all nanamed after Galileo Ferraris. It is open to competitors of all nations, one of the essential conditions being that it shall be shown at the exhibition and submitted there to a practical test. A committee of international authorities will be appointed to award the prize.

Digest of Current Electrical Literature

American and Foreign.

by Carl Hering.

Dynamos, Motors and Transformers.

ELECTRIC GENERATORS. Parshall and Hobart. Lond. "Engineering," Feb. 11.—In this continuation of their serial (see "Digest," last week) they discuss the effect of temperature upon insulation resistance, and the importance of freeing the insulating materials from moisture; it includes a description of the insulation testing methods for factories; the insulation may be tested either for the resistance or the disruptive strength, and for practical purposes the latter is preferred. They then describe in detail, with good illustrations and some working drawings, an apparatus which has been evolved after much experimenting, and has been found very suitable for factory work; it consists of a step-up transformer, working drawings of which are given, a water rheostat with two copper plates in a glass jar, a Kelvin electrostatic voltmeter of the ordinary type for the secondary voltage, a testing board for holding the samples, and consisting of two brass discs, between which the sample is placed, and an oven for keeping the sample at the required temperature. The step-up transformer is described in detail, and is followed by the method of testing.

COMMUTATING AND CONTINUOUS-CURRENT DYNAMOS.—Lond. "Elec.," Feb. 11.—An editorial discussing the recent American paper of Reid, and of others; the paper by the former is thought to be a very clear exposition of the subject, but disagreement is expressed with some points in it.

SINGLE-PHASE MOTORS. Eborall. Lond. "Elec. Rev.," Feb. 11.—In this continuation of his long series he describes the construction of the stationary and the rotating parts.

SHIELDED CONDUCTORS. Still. Lond. "Elec. Rev.," Feb. 11.—Another reply in his recent discussion with Price (see "Digest," last week), who, he thinks, has again missed the point.

ARMATURE WINDINGS. Rice. "Amer. Elec.," Feb.—The first of a series of articles on different forms of armature windings. Bipolar wave and lap windings are described, diagrams and tables being given for each.

HOME-MADE ALTERNATOR. Fells. "West. Elec.," Feb. 19.—A short article giving an illustrated description, including working drawings, of a small, cheaply made 10-pole alternator of the radial-pole type.

DESIGNING SMALL MOTORS. Poole. "Amer. Elec.," Feb.—The design of small motors is illustrated by a numerical example. The reluctivity of the magnetic circuit is not calculated, but a table is given of ampere turns per inch of length for various materials at different densities.

Lights and Lighting.

ARC LAMPS. Richard. "L'Eclairage Elec.," Feb. 5.—Illustrated descriptions, taken from patents, of a recent improvement, chiefly in enclosed arc lamps.

INCANDESCENT LAMP.—"Eng. and Min. Jour.," Feb. 19.—A note stating that Welsbach has recently completed important investigations in the application of the rare earths to the filament of an incandescent lamp, and he claims to be manufacturing such filaments and obtaining an increased light with the expenditure of much less current; no details are given at present, and the patents are not yet published; this is thought to be the reason why the English Welsbach Company recently increased its capital.

CANDLE-POWER OF SEARCH LIGHTS.—"Amer. Elec.," Feb.—The candle-power of a search light is obtained by equating the total flux of light from the area of the crater exposed to the reflector, with the total flux from the opening of the search light; that is, by multiplying the area of the search light opening by the candle-power of the ray, and equating with the product of the exposed crater and the hypothetical candle-power, which latter is the unknown quantity in the equation, and when found, is the commercial rating of the search light. As an example, if a beam has a diameter of 20 inches, and its candle-power is 2000, and the diameter of a circle equivalent to the area of the crater is .5 inch, then the rating of the search light would be 3,200,000 candle-power.

Power.

TEST OF A COAL MINING PLANT.—"Eng. News," Feb. 24.—A long extract from a very long thesis by Buck and Belsley, of Cornell University, and which is very well spoken of editorially; it gives the results of tests made under working conditions at a plant at Maybeury, W. Va.

TRANSMISSION PLANT. Tandy. "Amer. Elec.," Feb.—A description of a plant at Butte, Mont., for electric lighting, street railways, and ore reduction works. The distance is 20 miles, and the head 60 feet; there are four 1000-hp three-phase generators; the current will be stepped-up to 15,000 volts; the line consists of two circuits of six No. 1 soft-drawn copper conductors. The entire cost including two storage dams and a step-down transformer equipment for the sub-station in Butte, will be $400,000.

THREE-PHASE FACTORY PLANT.—"Elec. Eng.," Feb. 17.—A brief description of the plant at a piano and organ factory in Chicago, which is said to show the suitability of multiphase apparatus for shop transmisson.

Traction.

ROAD VEHICLES. Beaumont. Lond. "Elec. Eng.," Feb. 11.—The beginning of a reprint of his inaugural address before the Society of Engineers. It appears to be chiefly on road transport, roads and tramways; he appears to indicate the extinction of tramways and the enormous extension of motor vehicles following the construction of good roads; he defines tramways as being "metallic admissions by engineers and the public of the badness of ordinary roads."

ELECTRIC LOCOMOTIVE.—"Zeit. fuer Elek.," Feb. 6.—An illustrated description of a small narrow-gauge 9-ton locomotive with a 15-hp motor, which is intended to draw freight and passenger cars on a small line connected with a brewery in Austria.

ACCUMULATOR TRACTION ON RAILS AND ORDINARY ROADS. Epstein. "Jour. Inst. of Elec. Eng.," Feb.—A reprint of the complete paper, with a long discussion, which was noticed in the "Digest," Dec. 4, 11 and 25, and Jan. 8 and 15.

WORM GEARING AND RAILWAY TRACTION.—"Amer. Elec.," Feb.—An argument in favor of worm gearing for electric railway motors. Among the advantages advanced are the possibility of employing a motor of high speed with worm gearing, which means great output with light weight; the very light weight that bears directly on the axle, and the smaller cost due to the smaller size. On the road one of the advantages would be that as the worm gear is not a reversible combination a car would stand still on a grade without a brake, and if the car should get beyond control it would simply be necessary to pull down the trolley, when it would stop; a combined brake applied to the motor shaft would also stop the car with the application of much less force than at present; the reduced size of the worm gear motor would enable much more powerful equipments to be placed underneath cars than is at present possible, while the repairs would be less expensive. The conclusion is that the worm gear holds out too many advantages to the designer of street railway motors to be neglected, and that the stock argument that this system has been tried and proven unsatisfactory is not a valid one.

CAR TESTING.—"St. Ry. Rev.," Feb. 15.—A brief illustrated description of the Herrick portable switchboard for making the different tests connected with the inspection of car equipments. The tests which can be made are enumerated, and the advantages of making such tests are pointed out; he states, for instance, that much can be learned from the temperature of the motors at the ends of the trips, as it shows the efficiency of the motorman and the unbalancing of the two motors. He states that the aggregate cost of maintenance of all the street railways in the United States is over $18,000,000 per annum.

TESTS OF A TRACTION PLANT.—"St. Ry. Rev.," Feb. 15.—A supplement in the form of a large plate giving the logs of tests of the Chicago Electric Traction Company's plant and cars.

CHANGING A CABLE TO A CONDUIT LINE.—"Eng. News," Feb. 24.—A short description, accompanied by a large double-page plate, of the changing of the old cable road in Washington to a conduit electric road; other descriptions have already been referred to.

BOOSTERS FOR TRACTION.—"St. Ry. Rev.," Feb. 15.—An illustrated article of a general character on the booster, with illustrated descriptions of the way it is applied in a number of installations.

JUNGFRAU RAILWAY. Bayly. "Elec. Eng.," Feb. 24.—An illustrated article describing this mountain road in the high Alps; plans, elevations and views are given, including also a drawing of the locomotive.

MAIL VAN.—"Elec. Eng.," Feb. 24.—A reprint, with the illustration, of the short article noticed in the "Digest," last week.

ELECTRIC RAILWAYS IN THE UNITED KINGDOM.—"St. Ry. Rev.," Feb. 15.—Reprints of condensed tables giving some general data for the railways in existence and under construction.

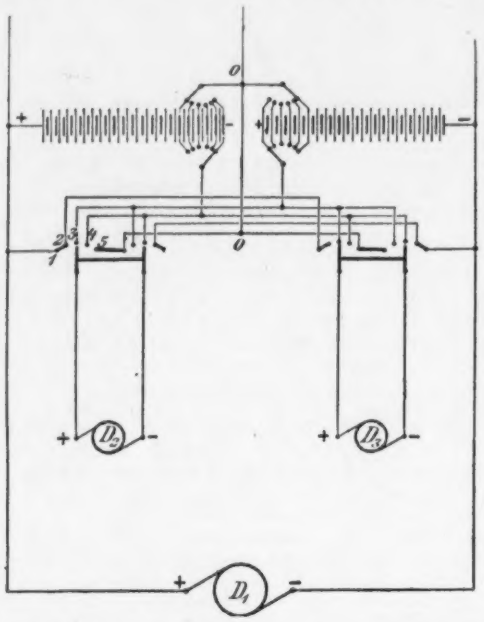
OPERATING EXPENSES OF CONNECTICUT RAILWAYS.—"St. Ry. Rev.," Feb. 15.—Extracts from the annual report of the commissioners for the year ending September, 1897; considerable tabular data is given in the abstracts. The report shows that the railways are in anything but a prosperous condition; the average earnings per car mile were 19.60 cents, which is a decrease compared with the preceding year; the average dividends dropped from 3.7 to 2.8 cents; the traffic on most of them has de-

creased. The tables give the itemized operating expenses in dollars per car mile; only 33.8 miles of new track were laid during the year.

RELATIONS BETWEEN STREET RAILWAYS AND MUNICIPAL CORPORATIONS.—"St. Ry. Rev.," Feb. 15.—A reprint of the text of the report of the special commission in Massachusetts; it is very long, and is to be followed by what is said to be a large amount of valuable data of street railways in America and abroad.

Installations, Systems and Appliances.

BALANCING MACHINES FOR THE THREE-WIRE SYSTEM. Kuegler. "Elek. Zeit.," Feb. 10.—A short article explaining his system, which has been in use for some time. It is illustrated in the adjoining diagram; the two smaller dynamos each develop half



the voltage of the outside wires, and are preferably coupled together on the same shaft, and driven by a belt from the main dynamo. Each of the small ones may be connected by the switches in various ways, as will be seen from the connections. It has the advantage over the method described by Gruhn (see "Digest," Dec. 4) in that in the latter the machines must be constructed so as to increase the voltage, but this is not required in the present case, as the small machine will run as a motor, giving its power back to the main dynamo; the loss of energy involved in this transformation is not of importance, as the batteries should not be very much unbalanced in a well-regulated system, and the time required is proportionately very small. Two small machines are interchangeable for their various functions, and can therefore also be connected in parallel, and one will answer as reserve for the other.

CHARGING.—"Zeit. f. Beleucht.," Feb. 10.—The beginning of an article of a general character discussing various methods which have been described.

RULES AND REGULATIONS.—"L'Elec.," Feb. 5.—The beginning of a translation in French of the rules adopted by the Electric Society of Vienna.

NOTTINGHAM.—"Lond. "Elec. Eng.," Feb. 11.—An illustrated description of the direct-current station using the three-wire system.

ALTERNATING CURRENT PATENTS. Hunter. "Amer. Elec.," Feb.—A letter to the editor, in which he takes exception to criticisms on some recent patents issued to him; he claims that one of his patents covers the entire art of alternating current working; he also says that the modern electric car as used to-day, with every appliance, was built, constructed and operated by him before anyone else.

BRUSH ARC MACHINE CONTROLLER.—"Amer. Elec.," Feb.—A regulation of a Brush machine became somewhat erratic, and it was found that when the door of the controller was opened the current became steady; this door, which was of heavy iron, was then replaced by a wooden one, after which there was no further trouble.

CONNECTING UP A METER. Sterling. "Amer. Elec.," Feb.—A case is described where a meter was connected for some time on the neutral wire of the three-wire system, the two sides of which were considerably out of balance.

Wires, Wiring and Conduits.

FUSES VS. CIRCUIT BREAKERS. Sachs and Cartwright. "Amer. Elec.," Feb.—In answering an objection to enclosed fuses, that no two manufacturers would produce a similar type, and therefore the fuses placed upon the market would be of all lengths and dimensions, Sachs replies that the mechanism of the various types of circuit breakers now on the market are similarly diverse, and not interchangeable. A statement having been made in a previous article that an air chamber was necessary in the enclosed fuse, this is disputed by Sachs, who claims that an air space is not at all necessary. Cartwright gives a list to date of patents on the enclosed fuse, of which there are eleven; the first five patents relate to naked fuses enclosed within a tube; the sixth, issued to J. Sachs, shows a fuse surrounded by a chemical substance that combines with the metal when abnormally heated; the next is for a fuse closely surrounded by asbestos, the central portion of the fuse having less carrying capacity than the ends; the eighth is for a fuse surrounded by loose asbestos, but with an air space immediately about the fuse in the centre of the case; the succeeding patents are combinations of one or more of the elements in those already mentioned.

INTERIOR WIRING. Knox. "Amer. Elec.," Feb.—The first of a series of articles on interior electric wiring. It starts with the floor plans and outlines the method of procedure in laying out outlets and circuit wiring. The number of cubic feet of space per 16-cp lamp will vary between the limits of 300 and 1000, the former figure serving for ball rooms and other places where unusually brilliant lighting is required, and the latter where only a fair amount of light is needed, and where the ceilings and walls are white. For the average case it is safe to allow from 500 to 700 cubic feet per lamp.

MERCHANT MARINE WIRING. Countiss. "Amer. Elec.," Feb.—A description of the particular features of wiring aboard merchant steamers.

Electro-Physics and Magnetism.

THEORY OF THE ELECTRIC ARC. Jamieson. Lond. "Elec. Rev.," Feb. 11.—He criticises unfavorably Blondel's recent method of searching for a back E. M. F., and then describes a hypothesis which he himself offers for the action of the arc, and founded on observations and experiments. He thinks it possible and probable that the carbon molecule becomes dissociated, forming two divalent molecules; the tetravalent molecule may be assumed to be a compound of the two divalent, which may be termed carbide of carbon; this dissociation takes place at the surface of the positive carbon; if this be the case, the formula for electrolytic action should hold good; on this assumption the electrolyte is carbide of carbon and the ion divalent carbon, whose chemical equivalent is 6; on this basis he makes some calculations, obtaining about 40 volts (calculated to the ninth decimal!), which is almost exactly that found by experiment. He then carried out the same observations with iron as the electrodes, assuming ferrous ferride as the electrolyte, and found that the calculated and observed values agreed. He suggests that the electrical energy is absorbed without heat, to keep up this dissociation, and this accounts for the counter E. M. F., which he assumes to be the energy of chemical affinity required to keep divalent carbon in that form; but these carbon molecules at once combine with others to form tetravalent carbon, giving off heat and light; some, however, are carried across, forming a conductor between the positive and negative carbons, and this amount is almost exactly one-tenth of the total. The results of his researches are promised in detail in that journal.

THERMO-ELECTRO COUPLE.—Lond. "Elec.," Feb. 11.—A note stating that one recently patented in Germany consists of iron and an alloy of copper with 40 per cent. nickel; it has the peculiar feature that the resistance is not affected by the temperature; next to the bismuth-antimony combination, it is said to be the most sensitive and strongest yet discovered.

DETERMINATION OF MAXWELL'S RATIO. Lamotte. "L'Eclairage Elec.," Feb. 5.—A description of Miss Maltby's researches, in which the mean result was 3.015. A table is also given containing a large number of other determinations.

CALCULATION OF ALTERNATING CURRENTS. Janet. "L'Eclairage Elec.," Feb. 5.—A brief reply to the recent discussion of his article by Guilbert (see "Digest," Feb. 5).

UTILIZATION OF ATMOSPHERIC ELECTRICITY. Sahulka. "Zeit. f. Elek.," Feb. 6.—A brief description of the method of v. Leon, who claimed that the electricity of the atmosphere could be utilized. The writer shows that the strange results obtained were due to other causes, and claims that for theoretical reasons such utilization of the atmospheric electricity is entirely impracticable; it is only during lightning discharges that momentary energy is set free. He is about to make some tests, and if the apparatus is a success he will describe it in that journal.

ELECTRIFICATION OF AIR. Warburg. Lond. "Elec.," Feb. 11; abstracted from the "Wied. Ann.," 13.—Descriptions of experiments, in which he blew air through a stream of electric wind, catching it on a wire gauze; the balance of evidence seems to be against the direct electrification of gas.

PERMANENT MAGNETS. Chistoni and Vecchi. "L'Eclairage Elec.," Feb. 5; abstracted at some length from the "Nuovo Cimento," Sept.—They made experiments with Valtrompia steels, which contain about 6 per cent. of tungsten, and used hollow and solid cylinders, measuring the magnetic moment and its relation to the moment of inertia; the results are given in a table. Among other things they state that for the same length and external diameter simple bars tempered very hard, or tempered several times, will give the best magnetic moment; if the maximum relation of this moment to the moment of inertia is desired, the best results are obtained with hollow magnets; if a large magnetic moment and a rel-

atively small moment of inertia are both desired, a hollow magnet of sufficient thickness will be best. The variation of the moment with the time is also discussed, and it is said that if after magnetization the temperature is varied several times between 0 and 70° C, the magnet will arrive earlier at its stationary state; the changes are more rapid and greater if the temper has not penetrated sufficiently; the time it takes to reach its stationary value increases with the mass.

THE POWER FACTOR.—"Amer. Elec.," Feb.—The usual method of defining the power factor as the cosine of the angle of lag is criticised, and it is here defined as a fraction expressing the part of the impressed E. M. F., which is free to do work. If the voltage is 50 and the current 10, with no inductance in the circuit, the watts consumed would be 500; with a power factor of .6, the watts would be $30 \times 10 = 300$, for the reason that 20 volts of the impressed E. M. F. are counterbalanced by an inductive E. M. F., in the same manner that the useful E. M. F. of a battery of twenty-five storage cells would be reduced from 50 volts to 30 volts, if five of the cells were connected in opposition.

INDUCTANCE AND CAPACITY.—"Amer. Elec.," Feb.—Inductances and capacities in series are treated, the principles being illustrated by numerical examples.

MAGNETIC AND ELECTRIC PROPERTIES OF IRON AT HIGH TEMPERATURES. Morris. "Sc. Am. Sup.," Feb. 26; reprinted from "Nature."—A short article giving a condensed description of his recent researches (which have already been published); one of the objects was to ascertain exactly in what way the specific magnetic resistance of iron changes at the critical temperature at which the magnetic properties nearly disappear, in order to throw light on the molecular stage called magnetic.

MAGNETIZING GALVANOMETER NEEDLES.—"Amer. Elec.," Feb.—A coil of 50 turns of No. 16 wire was used, and the needles were made of a double length of steel tape, which before being hardened was nicked with a file in the middle. A number of pieces of iron wire were cut to fill the interior of the coil, and the pieces of steel to be magnetized were laid lengthwise along the exterior; current from a six-cell storage battery was turned into the coil and continued until it became rather warm.

MAGNETIC WORK IN MARYLAND.—The Maryland Geological Survey has published its first report, which includes The History and Objects of Magnetic Surveys by Bauer. It is published under separate cover by the Johns Hopkins Press.

Electro-Chemistry and Batteries.

ACCUMULATOR.—"Zeit. fuer Elek.," Feb. 26.—A short account of a Russian society paper by Jaremin, who after long and extended researches claims to have been successful. The abstract is very brief, but it appears that he fills the space between two plates with crushed glass of a particular form, and uses more concentrated acid, the cell being closed hermetically; the results are said to have been surprising; an accumulator was in use for years and resisted very severe tests.

CHLORIDE ACCUMULATORS.—Lond. "Elec. Rev.," Feb. 11.—The beginning of a well-illustrated description of a factory near Manchester, England.

REVERSIBLE CELLS. Darrieus. "L'Eclairage Elec.," Feb. 5.—A continuation of his long article (see "Digest," Feb. 19); he describes his experiments tending to confirm his theory; no general conclusions are drawn; it is to be continued.

ELECTRO-CHEMICAL TREATMENT OF ORES CONTAINING PRECIOUS METALS. Webber. Lond. "Elec.," Feb. 11.—The beginning of a reprint in full of his paper (see "Digest," last week). The discussion is continued in the Lond. "Elec. Eng.," Feb. 11.

WHITE LEAD. Cowper-Cowles. Lond. "Elec. Rev.," Feb. 11.—After a description of the old Dutch process, which is a slow and tedious one, he describes a number of the electrical processes; the carbonated lead manufactured electrolytically is found to be more or less crystalline and hydroscopic and has not the same covering power. In one of these (presumably his own) lead sheets are packed with coke, strips of tin making connection between the lead and the carbon; when subjected to warm vapors of acetic acid, carbonic acid and air, an electrical action is set up which hastens the corrosion and reduces the time to five weeks as compared with ten and fifteen weeks required by the Dutch process; the corroded plates are then subjected to a process similar to the ordinary one. Another consists in electrolyzing a 10 per cent. solution of sodium nitrate, the anode being lead and the cathode copper, caustic soda being produced around the cathode and the lead dissolving as a nitrate; the two solutions are then mixed, which precipitates the lead as hydrate, which is then treated with sodium nitrate, the caustic soda being made available again by recarbonization. In a similar process of Browne the solution is an acetate or nitrate of an alkali base and the lead is precipitated by mixing the hydrate, being carbonized by exposure to the air or carbonic acid. Another consists in passing the current over an anode of lead through an alkaline electrolyte, consisting of a salt of ammonium in combination with any acid producing a soluble lead salt and a bicarbonate of the alkali; the cathode is of any suitable material; hydrated carbonate is formed, due to the free carbonic acid gas at the anode; the acetic and bicarbonate of soda are continuously regenerated. In another, acetate of ammonia is decomposed electrolytically with lead anodes, white lead being precipitated on mixing the two solutions, which were separated by a diaphragm. In another, dilute nitric acid is electrolyzed with lead anodes; the salt formed is said to be precipitated as white lead and any silver is recovered on the cathode.

ELECTROLYSIS OF PLATINUM CHLORIDE. Kohlrausch. Lond. "Elec.," Feb. 11; abstracted briefly from the "Wied. Ann.," No. 13.—He electrolyzed two forms of platinum chloride and found the amount of platinum deposited very different from what might be expected; in one experiment he obtained a valency for the platinum between 2 and 3, hence its value is not 4 and certainly not 8; one of the salts shows a still more extraordinary behavior; at low densities no platinum at all is deposited and at greater current densities it appeared as a gray mass turning white on ignition; at the anode oxygen instead of chlorine is given off.

ELECTROLYSIS OF COMPLEX FLUORINE SALTS. Miolati and Abisi. "L'Eclairage Elec.," Feb. 5.—An abstract of a paper from the Italian.

ELECTROLYTIC DECOMPOSITION OF SOLUTIONS IN WATER. Glaser. "Zeit. f. Elektrochemie," Feb. 5.—The first part of an article of a theoretical nature. He develops a formula for the E. M. F. of decomposition of water, based on the osmotic theory.

MOTIONS OF MEMBRANES BETWEEN THE ELECTROLYTES. Braun. "Wied. Ann.," No. 13; noticed briefly in the Lond. "Elec.," Feb. 11.—He showed that certain molar movements may be produced instantaneously. The abstract is reprinted in "El'ty," N. Y.

SUPPORTER FOR ELECTRODES. Lorenz. "Zeit. f. Elektrochemie," Feb. 5.—An illustrated description of a cheap and simple support for laboratory researches.

JACQUES CELL. Anthony. Thomsen. "Amer. Elec.," Feb.—Anthony describes some experiments which demonstrate that oxygen gas conveyed into a cell acts as a depolarizer and also acts to increase the current, while an inert gas will not do so; oxygen gas conveyed into the Jacques cell increased the current 3 to 1, and an ammeter in circuit indicated the instant that the flow of gas was started or cut off; for the oxygen to take part in the development of electrical energy in the Jacques or any other galvanic cell it is only necessary that it come into electrical contact with the cathode, which it may do by entering into combination, going into solution, being condensed upon the surface of the electrode, or absorbed by it; some of his experiments even seem to indicate that merely damp oxygen in the gaseous form may so act. Prof. Julius Thomsen discusses the theory of the Jacques cell, and concludes that the process in the cell is as follows: The oxygen introduced into the cell is occluded by the iron, and the whole apparatus has thus the same character as the galvanic cell; the electric current produced will, as usual, decompose the water in the hydrate of sodium, the oxygen will go to the carbon, the hydrogen to the oxygen, where it will combine with the occluded oxygen, and the result of this reaction will give an E. M. F. which, he says, is difficult to work and expensive to keep in active condition, will be of no practical value as a producer of electricity. very near to 1.1 volts; he is of the opinon that the Jacques cell, The letter of Professor Thomsen contains an interesting illustration of the theoretical calculation of E. M. F.

COPPER DEPOSITING PROCESS.—"Eng. & Min. Jour.," Feb. 19.—A note stating that the Anaconda Copper Mining Company is negotiating for the use of the new Elmore refining process. The old process was not a success, but it has recently been improved by Secretan and others, and it is now claimed that excellent sheets and tubes are constantly being made; the improvements are chiefly in unpatentable details preventing foliation and the formation of pin holes, which made the old process unsatisfactory.

Units, Measurements and Instruments.

MEASURING MAGNETIC FIELDS. Bouty. "L'Elec.," Feb. 5.—A reprint of a short Academy paper, in which he describes a new method of measuring the intensity of magnetic fields. It is based on the "reciprocal induction of electromagnetic action" in the Lippmann mercury galvanometer; a liquid conductor, which may be ordinary water, flows normally to the lines of force of the field to be measured; with the aid of the capillary electrometer the E. M. F. induced between the upper and lower surface is measured; knowing the amount of flow the intensity is then calculated; the formula which he gives and which is very simple, is that the intensity is equal to this E. M. F. multiplied by the thickness of the stream in the direction of the lines of force, and divided by the amount of flow, which latter quantity is equal to the velocity multiplied by the above mentioned thickness and by the height in the direction normal to the lines of force and to the direction of the flow. The E. M. F. is independent of the nature of the liquid or its concentration, and polarization introduces no errors; with water as the conductor high speeds may be used, increasing the sensitiveness; the only precaution necessary is perfect insulation of the electrodes.

MOTOR TESTING BRAKE.—Lond. "Elec.," Feb. 11.—A short illustrated description of a convenient form of Prony brake for testing small motors. The two ends of a strap wrapped around the pulley lead to two points on a horizontal bar suspended at a point

between them and having weights attached at one end; the suspension point may be raised or lowered to regulate the pressure on the strap so as to keep the arm in a horizontal position; the whole apparatus hangs from a tripod.

THERMIC MERCURY AMPEREMETER. Camichel. "L'Elec.," Feb. 5.—A reprint of a short Academy paper, in which he describes an improved form of the instrument, the original form of which was described in a previous paper; it is more sensitive and portable. In a subsequent paper he intends to describe its use in connection with the standard ohm as a thermic volt standard.

REICHSANSTALT.—"Elek. Zeit.," Feb. 10.—The conclusion of the abstract noticed in the "Digest," last week. The present portion describes the extensions of the electrical laboratory and gives a brief statement of the results of the calibrations and testing of commercial instruments; it enumerates these but gives no results.

LIQUID RHEOSTATS. Webb. "Amer. Elec.," Feb.—In a test made with an ordinary whiskey barrel two horizontal circular iron plates were used as electrodes; with the two plates 26 inches apart and the difference of potential 486 volts, a current of 2.6 amperes flowed; with the plates seven-eighths of an inch apart, 228 volts gave 35.5 amperes, the water at the end of the hour being at a temperature of 175 degrees Fahr. The conclusions are that for a large current density a horizontal top plate is not advisable, a better form being a hollow cylinder long enough to give a sufficient surface. In calculating the size of a rheostat for a 10 per cent. salt solution, one-quarter ampere per square inch may be assumed and a resistance of 2.12 ohms per square inch of section and 1 inch length. In practice the best way is to make a strong salt solution, or one of washing soda in a separate vessel, and then add as much to the rheostat as may be necessary. Liquid rheostats are much more satisfactory for alternating than for direct current testing, as in the former the electrodes and solution are practically free of decomposition.

TESTING DYNAMOS.—"Amer. Elec.," Feb.—A method of testing small motors by attachment to a speed lathe is described and illustrated; also a method of making an efficiency test by thermal means.

SENSITIVE MIRROR GALVANOMETER. Hobart. "Amer. Elec.," Feb.—A description, with working drawings, of a cheaply constructed mirror galvanometer.

Telegraphy, Telephony and Signals.

TELEGRAPH AND TELEPHONE LINES OF THE WORLD.—"Elek. Zeit.," Feb. 10.—A brief abstract from the "Journal Télégraphique" for 1897; some of the figures are only approximation. For telegraphy: In Europe, 2,841,326; Asia, 500,203; Africa, 160,065; Australia, 350,141; America, 4,051,642; cables, 301,930; total, 7,903,377 km. For telephony: Europe, 1,000,000 km.; America, 1,800,000 km.; miscellaneous, 200,000 km.; total, 3,000,000 km. Adding to this that used for railroad telegraphy, 2,000,000 km., gives a grand total of 13,205,307 km. This total would reach 330 times around the world, or thirty-five times from the earth to the moon. More detailed tabular statistics, including receipts, expenditures, number of telegrams, area, etc., for telegraphy for 1896 are given in "Elek. Anz.," Feb. 10, but the authority is not given.

INDEPENDENT TELEPHONE COMPANIES.—"Elec. Eng.," Feb. 17.—A brief description, with numerous illustrations, of the new exchange at Cleveland and of the Delmarvia exchange at Wilmington, Del., which latter is said to be one of the largest and most successful of the independent exchanges in the East.

HOME TELEPHONE COMPANIES.—"Elec. Eng'ing," Feb. 15.—A very long article, giving the history of these companies in a number of cities; descriptions of others are promised.

AMERICAN TELEPHONE PRACTICE. Miller. "Amer. Elec.," Feb.—The current installment of this series is on branch and terminal multiple boards.

TELEPHONE SWITCHBOARD LITIGATION.—"West. Elec.," Feb. 19.—Extracts from the recent decision of the court, concerning the Scribner switchboard patent, which was recently sustained; portions of the patent are reprinted.

GENERATING ROOM SIGNAL. Brown. "Amer. Elec.," Feb.—In a building in which 1200 amperes were thrown on suddenly, an inexpensive signalling arrangement was devised to warn the electrician, consisting of a red incandescent lamp across a circuit breaker in the engine room which controlled that circuit; when the switch was thrown, this lamp lighted up.

ELECTRIC BELL ARRANGEMENT. Tompkins. "Amer. Elec.," Feb.—A bell was desired in a sleeping room, operated from the front door, but no wires could be run; a small coil with a swinging armature was added to the existing annunciator, and a bell was put in place of the push button in the annunciator circuit in the sleeping room, so that when the front door bell push was operated the bell in the room rang, nothing but the existing annunciator circuits being used.

Miscellaneous.

ELECTRICAL ENGINEERS FOR THE ARMY.—Lond. "Elec.," "Elec. Rev.," and "Elec. Eng.," Feb. 11.—Reprints of the circular published by the Government concerning the organization of the corps of electrical engineers who volunteer their services for the British army and navy. It is announced that the organization is now practically completed and that the members are largely from the Institution of Electrical Engineers; J. Hopkinson is commander.

GUTTA PERCHA. Obach. Lond. "Elec. Eng.," Jan. 14, 28 and Feb. 4.—The continuation of the reprints of his Cantor lectures. The "India Rubber World," N. Y., Feb. 10, is beginning a reprint in abstract. The "Sc. Am. Sup.," Feb. 26, also publishes a brief abstract, with a number of the illustrations of the manufacturing and testing machines.

DIRECT TRANSFORMATION OF HEAT INTO MECHANICAL WORK. Deprez. Lond. "Elec. Eng.," Feb. 11.—An abstract of the article noticed in the "Digest," Feb. 26.

ELECTRO-BIOLOGY.—Lond. "Elec.," Feb. 11.—A notice that a bi-monthly journal in the French language has just been started with the title "Annales d'Electrobiologie," under the direction of d'Arsonval, Tripier, Apostoli, Oudin and Doumer, the latter being the editor-in-chief; it is magazine size, and the first number contains articles on electro-medical subjects by these writers.

ABSTRACTS.—"Jour. Inst. of Elec. Eng.," Feb.—A number of abstracts of articles, all of which have already been noticed in the "Digest," though more briefly. It also contains a long classified list of articles appearing in some of the principal technical journals from June to November. After that issue the abstracts and classified lists will no longer appear in that journal, but instead there will be a monthly issue containing abstracts prepared by a joint committee of that Institution and the Physical Society.

WATERPROOFING FABRIC BY THE ELECTRIC CURRENT.—"Elec. Eng.," Feb. 17.—A description, taken apparently from a recent patent, of the process of Brevoort and Boehm. When a piece of wet cloth is placed between conducting plates and a current passed through it it will be waterproof after drying; it is believed the waterproofing is due to the formation of a metallic oxide from the positive conductor, which oxide enters into the goods.

BRANDING SEALS. Farmer. "Elec. Rev.," Feb. 23.—A description of the seal rookeries, with a brief mention of the electrical method of branding by means of hot platinum wire, which is claimed to be less painful than the use of hot irons. Recent experiments to improve the apparatus were made by using the electric arc under magnetic control.

CAR COUNTER.—"St. Ry. Rev.," Feb. 15.—A diagram of the counter for the Brooklyn bridge cars, noticer in the "Digest," Feb. 12. A short description is also given in the "Elec. Eng.," Feb. 24.

ELECTRICAL JOURNALS. Caldwell. "Amer. Elec.," Feb.—A letter, stating that the "Telegraphic Journal," the immediate predecessor of the "Journal of the Telegraph," made its first appearance on March 7, 1867, when it was succeeded by the last mentioned publication, the first issue of which appeared December 2, 1867, under the editorship of James D. Reid. It is stated that the "Telegrapher" was the first really successful paper in the United States devoted to the interest of the electric telegraph; its publication began in September 26, 1864, and continued for thirteen years, the late Franklin L. Pope at one time being its editor.

ELECTRICAL CATECHISM.—"Amer. Elec.," Feb.—The present installment of this serial deals with the rotary transformer.

MAGICAL CANDLESTICKS. Hopkins. "Amer. Elec.," Feb.—He describes an electrical apparatus for amusement, by means of which candles mysteriously extinguish and relight themselves at the wave of a magician's wand.

Electric Car Heating.

During the past winter the officials of the South Side Elevated Railroad Company of Chicago made some very careful and extensive tests of electric car heaters. The result, we are informed, was that the contract for the entire equipment was awarded to the Gold Street Car Heating Company, of New York and Chicago. The test car which the Gold Company equipped was supplied with twenty-four of the improved "Gold Standard" electric heaters. The heaters were wired to permit of six graduations of temperature, which was controlled by a regulating switch. The contract covers the entire equipment of the South Side Elevated Railroad, and calls for about 3000 electric heaters. This is said to be one of the largest contracts ever placed for electric heaters.

The wiring on the car is very simple, and at the same time the heaters are so connected as to render the regulation of temperature at all times very easy. The "Gold Standard" heater is about 20 inches long and 3 inches in diameter. It consists of a steel helix which is thoroughly covered with a glass enamel baked on at a temperature of over 2000 degrees. This covering forms a perfect insulator, and is in no way affected by the heated wires. The resistance coil is slipped on this enameled helix, and the ends of both the resistance coil and the supporting helix are made fast to the solid porcelain ends. A perforated iron casing fits over the porcelain blocks, and the whole, when assembled, makes a very attractive heater. A number of advantages are claimed by the Gold Street Car Heating Company for this heater. The resistance wire is of the company's own special composition, and is said to be absolutely noncorrosive. The coil is wound in an open pitch, and when placed on the helix is under no tension whatever. An easy and free circulation of air is obtained and there is nothing to obstruct the passage of the air through the heater. The heaters are light in weight, but strong and durable. They are neat in design and highly efficient.

Siphon Condenser.

The siphon condenser illustrated herewith is applicable to any purpose where a vacuum is required. In its installation no air pump is necessary, and it contains no working parts to get out of repair. It is guaranteed to maintain a 24-inch or a 26-inch vacuum. It is set at a height of 34 feet above the hot well, which is sufficient to clear itself of its discharge water and air by gravity alone. The water is fed into the side of the condensing chamber in a thin circular sheet, and passes down through the contracted throat with such velocity as to carry with it all the air passing over with the steam and in the condensing water itself. This condenser will siphon its own water safely up to 15 feet, maximum. Any ordinary type of pump may be used, but a low-duty steam, centrifugal or rotary pump is preferable.

Although the condenser is placed at a height of 34 feet above the hot well the vacuum assists the supply pump in a proportionate degree, so that with 24½-inch vacuum the actual lift of the pump is less than 7 feet. This is said to be the most economical type of condenser in the matter of water consumption. Its principal advantage lies in the water nozzle, which is adjustable, thereby admitting of close regulation of the water supply, at the same time maintaining the circular form of the stream as it enters the condensing chamber, and exposing the same large condensing surface. Even when nearly shut off there are no bare spots on the inside of the condensing chamber, the circular sheet of water simply being made thinner.

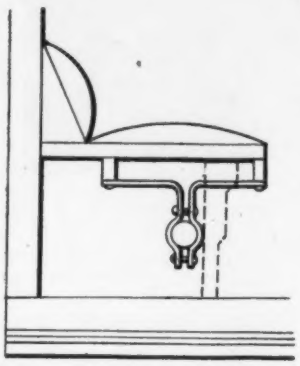
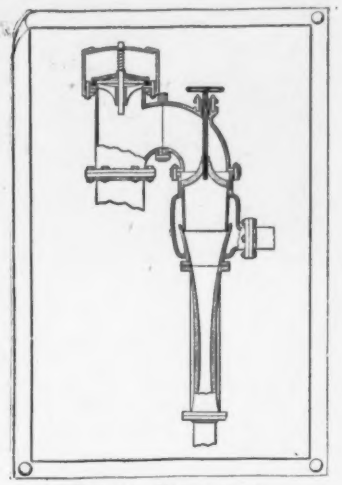


FIG. 2—LOCATION OF HEATER UNDER CAR SEAT.



SIPHON CONDENSER.

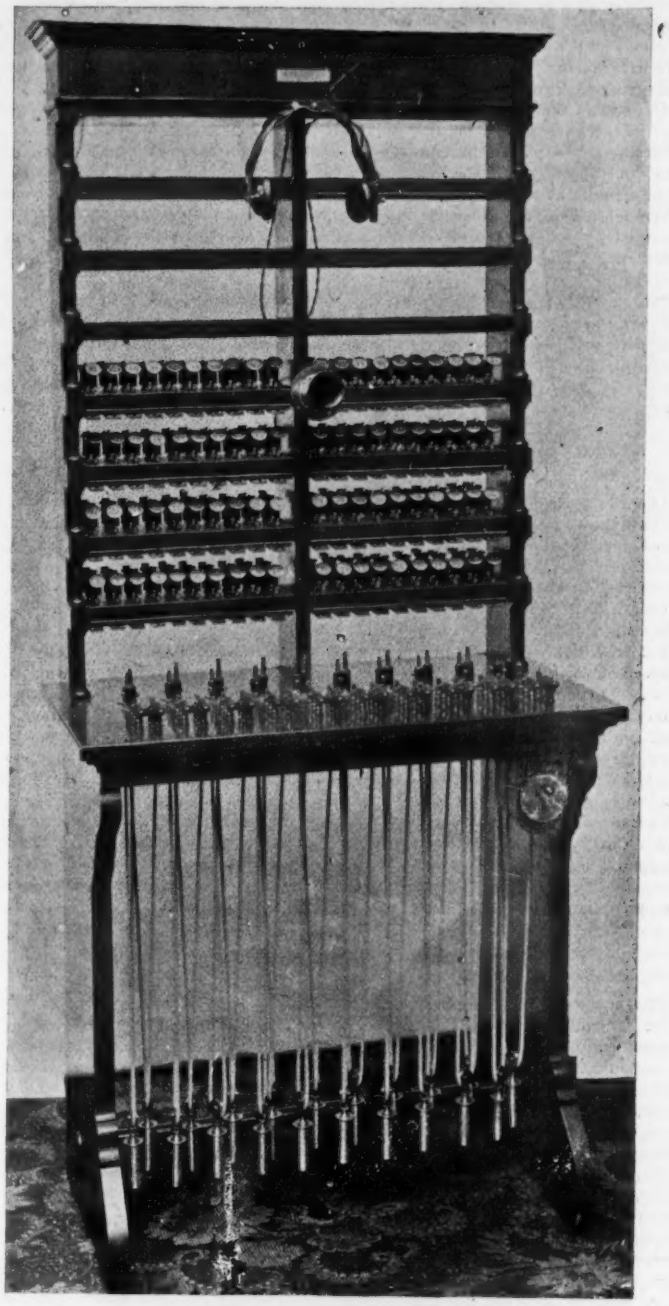
William Baragwanath & Son, Chicago, Ill., manufacturers of this siphon condenser, guarantee that it will not flood the engine cylinder, and claim a saving in fuel by its operation of 20 to 30 per cent., or a corresponding increase in power with the same steam consumption.

The firm furnishes plans for the construction of a very simple, inexpensive, durable and efficient form of cooling tower, which requires no fan or artificial draught. This enables any plant not conveniently located with reference to a body of water to be run condensing if desired, and it is sometimes resorted to as an actual economizer of water, all the condensation from the engine being available for boiler feeding which, in case of scarcity of water, or bad quality of the feed water, is sometimes a very desirable result.

A New Telephone Switchboard.

An improved central station telephone switchboard is shown in perspective in the accompanying illustration. It is manufactured by the Central Telephone & Electric Company, St. Louis, Mo., and is claimed by the manufacturer to be the most easily operated board on the market. Its most noticeable feature is the provision made to increase the number of drops at any time, as the service expands. The drops and spring jacks are placed on shelves, as shown. To increase the capacity of the board it is only necessary to send the detachable vacant shelves to the factory and have them filled with the additional apparatus. The additional equipment can be put in place in the cabinet by the most inexperienced person.

Each drop is composed of two coils wound to resistances which equalize the pulling power of both magnets. Where long lines are connected this is ad-



IMPROVED TELEPHONE SWITCHBOARD.

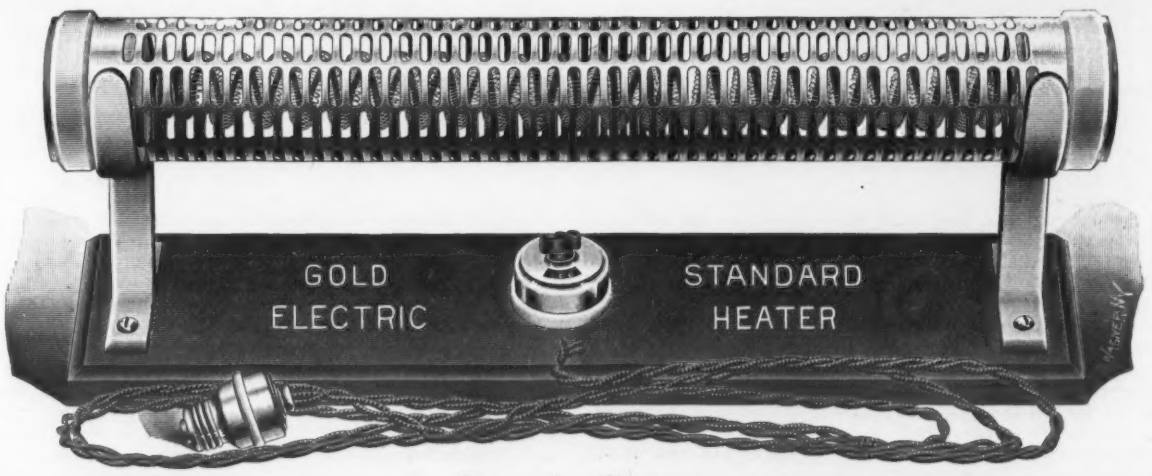


FIG. 1.—CAR HEATER.

vantageous, as it requires but little current to operate the drops. All drops are so placed that when the indicators are raised no parts of the drops project in front of the spring jacks, hence an operator cannot by accident drop an indicator while connecting the cords. Each spring jack is directly beneath the indicator of the drop to which it is connected, so that the operator has only to look when a call is made, and can simultaneously plug in and raise the indicator with one hand. The plug connectors constitute one of the greatest advantages of the board. Each set of plugs consists of a long and a short plug. The short plug is inserted in the spring jack of the calling line, which connects the subscriber direct to the operator's transmitter and receiver. When a call is received the operator lets the short plug remain in the spring jack of the subscriber calling, and takes the long plug of the same set and inserts it in the spring jack of the line desired. This plug automatically cuts out the drop and connects the generator direct to the line, thus leaving absolutely no resistance in the switchboard for the generator current to overcome. As soon as the subscribers are placed in connection the operator throws a knife switch in front of the plugs to the opposite side, thus connecting both cords in the same circuit, at the same time cutting out all parts of the switchboard, with the exception of the clearing out drop, which remains in circuit. The space occupied by 100 drops and spring jacks is only 20 inches by 24 inches, and a board of 200 drops may be so arranged that one operator can reach each drop and spring jack without leaving her chair.

The cabinets for these switchboards are made of cherry wood, highly polished and very handsomely finished. Each cabinet is furnished with a "Perfection" long-distance granular carbon transmitter, mounted on a nickel-plated adjustable arm. Each board is also provided with either head or hand receivers, as desired; a 25,000-ohm generator; a night alarm with switch; a guaranteed lightning arrester, and batteries for operating both transmitter and night alarm.

Electric Light at the Omaha Exposition.

The illumination of the grounds and buildings of the great exposition for which Omaha is now preparing will be made on a scale of magnificence unexcelled even by the wonderful effects obtained at Chicago in 1893. The fact that Mr. Louis Stieringer, the lighting expert of the World's Fair, is consulting electrician for the Omaha Exposition Company is a guarantee that the lighting effects will be of a character in keeping with the scope of this great Trans-Mississippi exhibition.

Not less than 2155 kilowatts in dynamos and transformers have already been ordered from the General Electric Company for purely illuminating purposes. In detail, the contract covers four 125-kw 2000-cp light Brush arc dynamos, of the multi-circuit type; four 12-kw and two 180-kw alternating current, high periodicity dynamos, operating at 1040 volts, together with 840 kilowatts in type H transformers of different sizes. Current for various power purposes will be supplied from a generator of 225-kw capacity, operating at from 500 to 550 volts.

The arc lamps will number 600, of 2000 candle-power each. These are to be of either the double or single carbon type, at the option of the General Electric Company, but if the latter are used they are to be arranged for fourteen-hour service. The contract also calls for the necessary exciters, and all the switchboard appliances for the operation of the above machines.

New Telephone Manufacturing Quarters.

The new factory of Messrs. De Veau & Co., at 27 Rose Street, New York City, is equipped with modern machinery for the manufacture of telephone apparatus. It is ample in proportion and extremely well lighted, having windows on three sides. The firm occupies the entire third floor, which is in the form of an ell. On the Rose Street end is the receiving and shipping room, where all the raw material that goes into the manufacture of telephones is received and the finished goods shipped out to customers. Next comes the office, which is partitioned off from the main room. It is a cozy room and receives excellent light from the front. Beyond the office is the machine room, which contains all the machine tools used in the manufacture and finish of telephones. Here are lathes, drills, screw machines and everything required in this particular line of work. An automatic screw machine is an interesting piece of apparatus, and turns out screw parts with absolute accuracy. The assembling room occupies the rear end of the building, and has large windows on two sides, through which an abundance of light enters, thus greatly facilitating the exacting and necessarily accurate work in the assembling of telephones. Along the sides of the room are large stocks of telephone boxes, magnetos and the various parts from which supplies are drawn for the work in assembling.

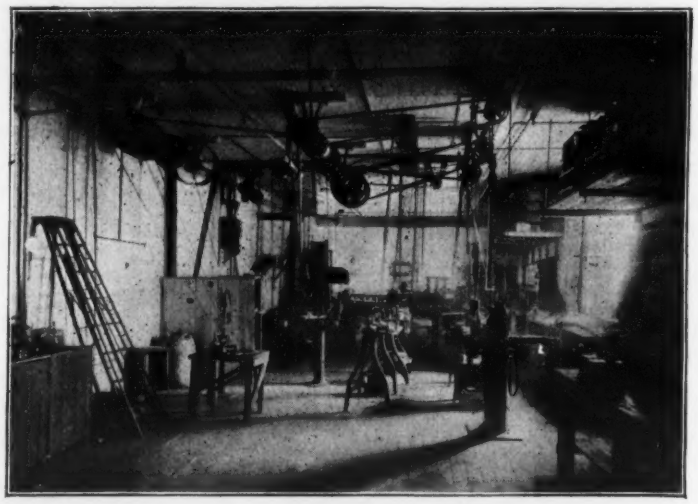
The telephones manufactured by Messrs. De Veau & Co. are of sufficient merit and novelty to warrant some special attention at this time. They are recommended as being very complete and excellent instruments in actual service. They are made with a view to giving first-class service at all times without the necessity of periodical supervision. In other words, these instruments when shipped from the factory are adjusted for all time, and with ordinary care they are guaranteed to give the best of service without any future adjustment. The greatest care is exercised in their manufacture to obtain these results, and the best of materials enter into their construction. The telephone switch in the magneto box is a great improvement on the ordinary standard switch. A greater sweep is obtained in its action, thus insuring a more reliable contact. The switch runs all the way across the box. The magneto is a superior instrument throughout, the armature being wound with silk insulated magnet wire.

The transmitter is a very interesting piece of apparatus. To the diaphragm is screwed a carbon disc about three-fourths of an inch in diameter, around the surface of which is provided a circle of hemispherical perforations. The back electrode consists of a thinner disc of the same diameter, having concentric ridges on the surface facing the diaphragm. Around the diaphragm disc is wrapped a piece of wool cloth, which is used for the purpose of holding the coal grain carbons in place between the diaphragm and rear discs. The granulated carbon is quite firmly packed between the two discs, yet there is a certain amount of flexibility to the carbon system at all times, which is secured at the back by placing the rear carbon disc on a spring. This spring is of sufficient tension to hold the carbon grains in firm contact, yet is yielding enough to insure a clear reproduction of the voice. The diaphragm and the carbon back of it are protected from moisture by a covering of oiled silk, which is stretched between the diaphragm and the mouthpiece. This silk absolutely prevents the admission of moisture to the granulated carbon. The wire terminal is riveted to the diaphragm, thus making it practically a solid

View of Assembling Room.

connection with no resistance. The conductors are led into the back of the instrument through holes in the metallic case, which holes are provided with fibre bushings to insure insulation. Insulation is also provided by means of washers and discs on the inside and outside of the metal back, thus securing an insulation from the metal parts of the instrument that is reliable at all times. The transmitter is a very sensitive instrument, and will work with one cell of any kind of battery. In holding the diaphragm in place the pressure is distributed all around the circumference, thus concentrating the vibrations at the centre, where they should be. To this no doubt are largely due the excellent speaking qualities of the instrument. Where a diaphragm yields at any point of the circumference and does not concentrate all its motion at the centre, it could hardly be expected to give the best results in practical use.

There is one fact Messrs. De Veau & Co. are proud of in connection with their work, and that is that everything that enters into the construction of their apparatus is American, no foreign material whatever being used. In the manufacture of their telephone receivers compound magnets are used. These magnets are very carefully shellacked to prevent their rusting. The firm also manufactures a watch case receiver, which is very well known and well made. All the wire used in the instruments of this firm is silk insulated. The thumb screws used on the telephone terminals are of a new form, and secure an ex-



View of Machine Room.

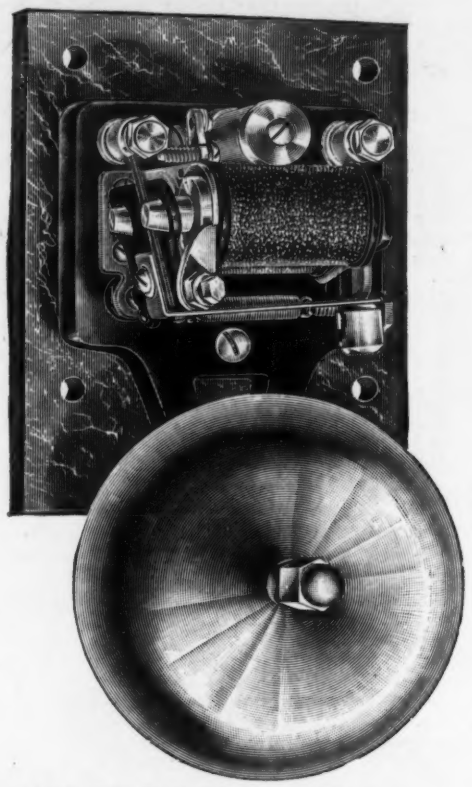
cellent grip on the wires. The screw does not go through the centre as in the ordinary kind of screw cup, but, instead, the thread is cut on the outside of the binding post, and over this a screw collar takes the place of the ordinary central screw. This collar therefore binds the wires on both sides of the hole, thereby securing an extraordinary grip and firm contact.

Messrs. De Veau & Co. furnished their telephones to many of the newer United States warships, including the "Iowa" and "Brooklyn," and the firm is now finishing an order for the Government for some of the ships, the desk sets of which are to be finished in gold. The firm also makes a marine telephone set which is used for diving work on the United States warships. A receiver and transmitter are placed within the diving bell for the use of the diver, in communicating with the the ship on the surface.

The accompanying illustrations represent the machine shop and the assembling room of the new factory.

High Tension Current Bell.

Messrs. Edwards & Co., One Hundred and Forty-fourth Street and Fourth Avenue, New York, have lately put on the market gongs for use on electric light circuits. The illustration represents their Vigilant bell, arranged for this class of work. Any of their bells, either electric or electro-mechanical, can be furnished to meet the requirements of the same service.



BELL FOR ELECTRIC LIGHT CIRCUITS.

This style of bell is mounted on a marbleized slate base, and arranged to operate on currents up to 500 volts. The idea of this new article is the use of a special resistance substance that will neither melt nor burn, which is placed in the circuit of the bell. The armature being attracted, shunts the coils of the magnet, leaving the resistance in the circuit. There is therefore no sparking, and the contacts cannot burn out, as at no time can more than one-sixth of an ampere of current pass through the bell.

A New Telephone Manufacturing Company.

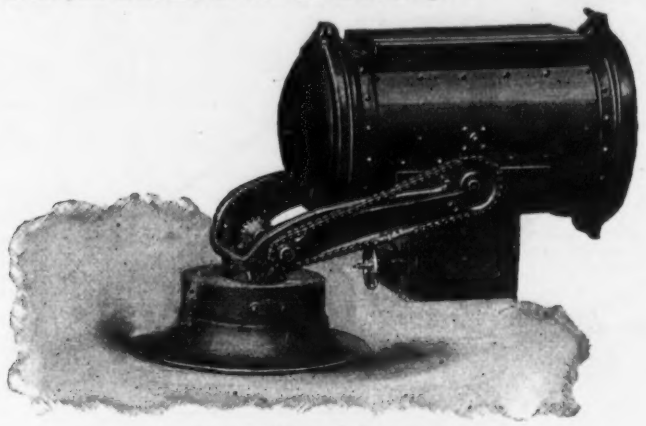
The Sterling Electric Company is a new concern having its headquarters in Chicago. It manufactures a line of telephone exchange central office equipment, including switchboards, transfer boards, distributing boards, cable terminals, protectors and a combined cable terminal and protector, together with several other telephone devices. The company proposes to build a line of apparatus similar to that used by the Bell Company, and with such equipment available independent companies will be able to compete with the old-established telephone companies to better advantage.

The switchboards that this company constructs are equipped with Cook's tubular drop, drop restoring devices, metallic circuit plug, combination ringing and listening key, standard jack, indestructible cords, pulley weights, etc. All sections of the boards are connected with the Cook transfer or trunking system. The cross-connecting board is of hard rubber and hard wood, 100 wires occupying a space of 52 inches in height and 2 inches in width. It is said to be simple and easy to manipulate. The combined cable head and protector is made with a cast-iron body, an aerial or underground cable entering at either end and the wires spreading to the sides upon connectors, which in turn carry the circuits through a combination of springs separated from a ground by carbon plates and mica insulation, and from the connectors, terminating upon the inside of the cable head with a heat coil, which parts on three-fiftieths of an ampere of current. The line is carried from the inside connectors to the distributing board. The outside or pole top cable terminal is circular in form. It is composed of three parts—the frame, the body and the cover. The frame is fastened directly upon the top of the pole, and the body is then securely bolted to the frame. The sides of the body are penetrated by rubber bushings, each bushing having two or four continuous connecting points projecting from either side. The bushings are air tight. The cable enters the bottom of the frame, the wires being spread to the inside connecting points upon the bushings, which are numbered consecutively, the spider or bridle wire taking the outside connecting points upon the bushing, thence to line. The terminal is entirely weatherproof.

The individual subscribers' station protector is a combination of springs mounted upon a porcelain base about 3 inches in diameter, one set of springs being separated from the ground by carbon plates insulated with mica, the other set being separated from the instrument binding posts by heat coils, which open under strong current pressure. A line fuse is used in connection with these protectors, being placed in the line at the cable pole between the spider and the line wire, and at the subscribers' station. It is in the form of a wooden tube 4 inches long and one-half inch in diameter. Both ends of this tube are fitted with solid brass connectors, which are united through the tube by a fuse wire of three amperes capacity. This combination of protectors and line fuse comprises the Cook complete protective system, and it is stated has the indorsement of the National Board of Fire Underwriters.

New Electrical Marine Projector.

We illustrate herewith a new type of high power lens mirror projector lately brought out by the Rushmore Dynamo Works, Jersey City, N. J., which make a specialty of marine equipment. This little light is intended for the smaller class of yachts, of 100 feet or under, and is not too large for the smallest boat that can float a dynamo to supply the current. The lens is 9 inches in diameter, and the total height is 15 inches. The projector weighs 40 pounds. It throws a clear, round, solid beam, and with eight amperes will show up a buoy one-half mile away on a dark night. The first projector of this type was installed on the racing yacht "Presto," built by Mr. Charles D. Mosher for Mr. William Mollenhauer. The beam is controlled by two distant controllers, one in the pilot house and the other aft on the bridge.



HIGH POWER PROJECTOR.

The Rushmore Works are building projectors in all sizes up to 72 inches in diameter for all classes of naval and commercial service. They have cut free from the foreign lens makers, and now have a fine lens plant of their own. They not only grind and polish the lenses, but prepare the special glass required. They have lately installed a large "sweating" furnace heated with crude oil vaporized by heated compressed air.

The Rushmore Works have in the last week sold over fifty projectors for all classes of service. Seven 14-inch projectors are being shipped to San Francisco, and four of the same size to Portland, Ore., for steamers fitting out for Alaska; also a complete plant consisting of one 6-kw and one 30-kw generating sets, switchboard and a forty-five ampere projector for the Alaska steamer "Cartina," now fitting out at Elizabethport for the Boston-Seattle Company, A 12-kw generating set and a twenty-five ampere projector has been ordered from Boston for the steamer "Susquehanna."

Carbon Resistances.

The use of wire, iron, steel ribbons, graphite, etc., for resistances has always been attended with more or less difficulty and trouble. Excessive heat, bulk and manner of arrangement have all been subjects of consideration, and numerous methods have been employed to overcome the various objectionable features encountered.

The Raster Carbon Rheostat Company, Chicago, Ill., has brought out a form of carbon rheostat which it claims to be a nearer approach to success than

CARBON MOTOR STARTING RHEOSTAT.

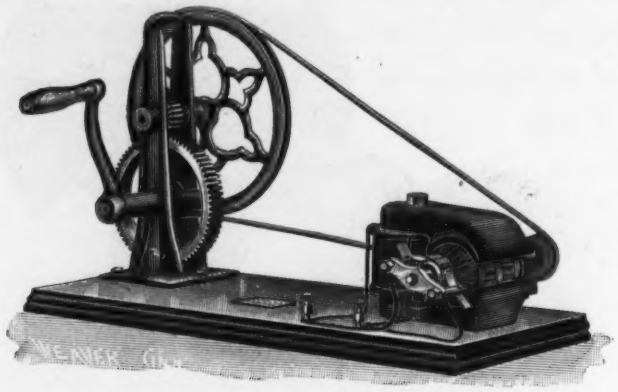
the result of any previous effort. The matter of contact has always been a cause of trouble. The Raster Company, however, states that it has devised a certain composition, which, when used with its especially compounded carbon, reduces the contact loss to a minimum and renders the utility of carbon as a resistance an established fact. This carbon resistance is capable of withstanding a higher temperature than any known metal resistance. The accompanying illustration represents the new Raster carbon motor starting rheostat. The apparatus is simply constructed, and all parts are interchangeable. It is

practically indestructible, being both fire and moisture proof, and it is not readily affected by a reasonable overload for a short period of time.

The carbon resistances made by this company are free from induction, and it is the company's intention to produce instruments for testing purposes. The construction of this carbon resistance is such that the radiating surfaces of the resistances proper are exposed to a continuous, practically unlimited and free flow of air. Thus, in the dimmers and regulators the company is able to perform the work required, under adverse circumstances, with a greater degree of safety than has been possible before. All circuits are accurately and positively controlled by the use of three resistances. The company is making, beside motors, starting rheostats, regulating rheostats, arc light resistances and all other forms of resistance.

Model Experimental Apparatus.

The illustration herewith is one of the model experimental dynamos manufactured by the T. and H. Electric Company, Elbridge, N. Y. This machine was designed for the use of students, instructors and amateur investigators.



Experimental Dynamo.

With it many interesting experiments can be made. It has an output of 75 watts, and can be wound for any voltage from five to twenty-five. The company furnishes it for direct or alternating current, or both combined. It is a well-made machine and simply constructed.

Some Important Apparatus of New Design.

Some interesting and novel instruments have just been put upon the market by Messrs. Elmer G. Willyoung & Co., of Philadelphia, for whom Mr. James G. Biddle acts as selling agent. The most important of these instruments is the new electro-dynamometer, upon which patents were issued to Prof. H. A. Rowland several years ago.

The Rowland dynamometer differs somewhat from all other instruments of this class in that it may be used on alternating circuits with shunts of various values, just as an ordinary galvanometer is used on direct current circuits.

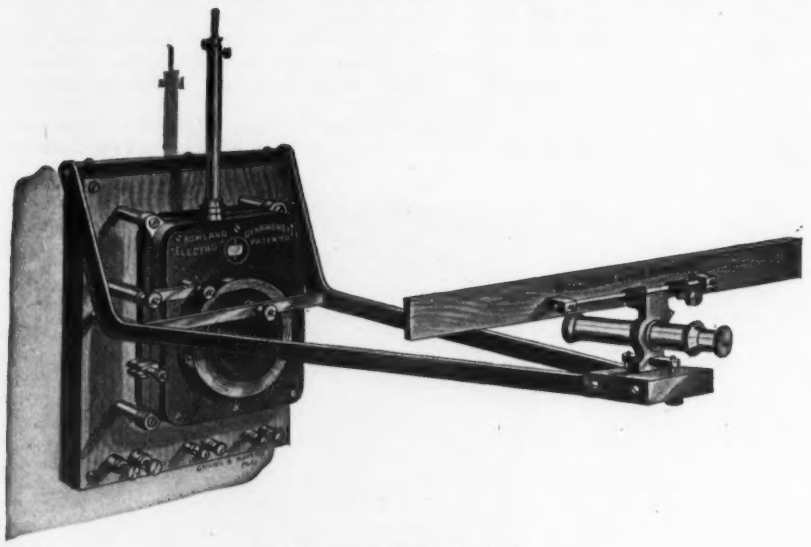


Fig. 1.—Dynamometer.

Essentially the instrument consists of a diminutive movable coil of extremely small self-induction, arranged to be put in series with variable known and somewhat high values of non-inductive and capacityless resistance. This series combination is itself arranged to shunt around values of low non-inductive and capacityless resistance capable of carrying large currents. The instrument will measure alternating currents from .0001 to 50 amperes; direct currents from .00000001 to 50 amperes; volts, alternating or direct, from .005 to 500 or more; watts, from .001 to 25,000, with a large range of amperes and volts; self and mutual inductances and capacities, either directly or in absolute measure, or by comparison with standard inductances or condensers; leakage and electric absorption of condensers, cables, etc., for any given alternating current or potential; the hysteresis of iron and losses under actual practical conditions; non-inductive resistances, such as those of liquid, and alternating currents for use in physiological experiments.

The instrument is illustrated in Fig. 1. It has its own telescope and scale permanently attached. Various accessory resistances and shunts are contained in a shunt box, which is arranged with sets of switches, enabling easy manipulation.

Messrs. Willyoung & Co. have also just brought out Professor Northrup's oscillating current galvanometer for Hertzian and resonance experiments, and

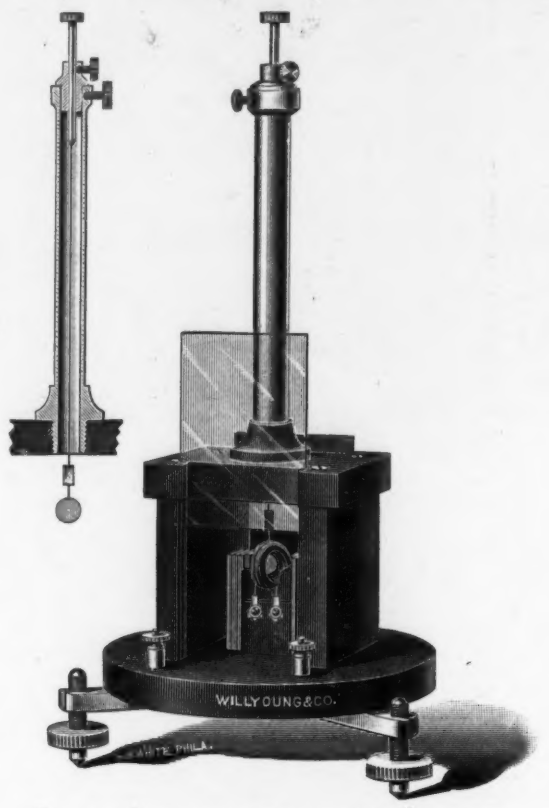


Fig. 2.—Oscillating Current Galvanometer.

for the detection and comparison of high frequency currents. This instrument is illustrated in Fig. 2, and will, it is stated, replace the coherer, vacuum tube and similar devices to good advantage in much of the usual Hertzian and resonance work, and prove as well of great service in many experiments with telephone currents, wireless telegraphy, etc.

The Willyoung high potential transformer for producing resonance phe-

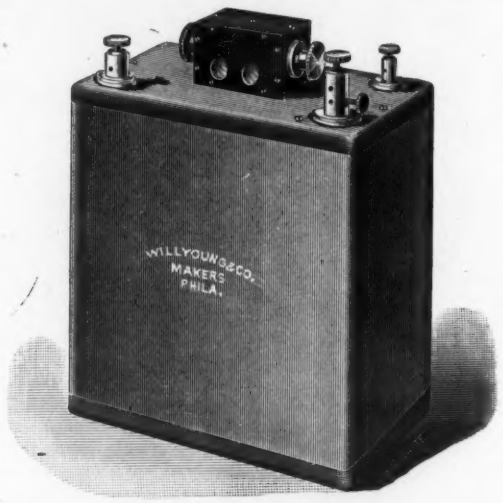


Fig. 3.—High Potential Transformer.

nomena, Hertzian waves and conducting vacuum tube experiments, etc., is illustrated in Fig. 3. It is claimed that with the assistance of this apparatus all experiments involving the use of oscillating currents, Pupin's resonance experiments, X-ray and vacuum tube experiments, etc., can be performed in the best manner. With the single exception of vacuum tube and X-ray experiments, where a unidirectional discharge is required, the high potential transformer is adapted to replace the induction coil. The transformer is enclosed in a cherry box highly polished, and is provided with a double discharge gap between balls made of non-arcing metal. This gap is enclosed in a hard-fibre box, so that the discharge is practically inaudible. In order to

obtain the best oscillations in some Hertzian experiments it is desirable that the partial arc which forms across the discharge gaps should be forcibly blown out. This requirement is provided for in this apparatus. In working with a transformer it is often desirable to obtain a high potential and still have a small current flow in the circuit of the secondary of the transformer. The result is obtained by inserting a small condenser in the circuit, the proper binding posts for connections being provided on the cover of the transformer box. The insulation of the transformer is so high that a three-fourths inch discharge can be drawn from its secondary without danger.

Improved Telephone.

A form of telephone which has several features of importance is being manufactured by the Schmidt & Bruckner Electric Company, 209 Greenwich Street, New York. One of the most noticeable improvements in construction is the entire absence of flexible conducting cords inside of the case.

In the accompanying illustration (Fig. 1) it will be noticed that the switch plug has no connection with a flexible cord, the chain being used only to prevent the loss of the plug. The segment represents the instrument terminal, while the numbered discs represent the terminals of the lines. In order to connect any one station it is simply necessary to insert the plug in the proper disc. At the back of each disc is soldered a pin of sufficient length to press upon a spring at the back of the case, inside, which spring constitutes the line terminal. This method of construction forms a positive contact, and one that can be examined at any time. All connections within the case are of this kind, thus doing away with the annoyances resulting from broken conductors hidden within the cord covering. The instrument shown is only one form made by this company. The company makes telephones of all the standard forms and others of special forms, which have commendable features.

The transmitter used by Messrs. Schmidt & Bruckner is said to be an improvement on the Ericsson Swedish transmitter. In the Ericsson instrument a disc of oiled silk is used to protect the carbon grain from moisture, but Messrs. Schmidt & Bruckner use a thin disc of shellacked silk for the same purpose. They also use a solid gold disc at the back of the diaphragm. In the Ericsson instrument a gold-plated disc is used. These improvements they say add very materially to the effectiveness of their instrument and make it much more satisfactory in operation.

The desk instrument (Fig. 2) is of neat design, and, like the other forms of telephones made by this company, compact. The rod to which the receiver hook is attached runs through the column to the base, where all the contact points are located. These are of the same kind as those already referred to. The instrument is a handsome one, and very serviceable.

These telephones are adaptable to all classes of telephone work, inside or outside. The voice is transmitted with its original character and clearness. The company's receiver is a sensitive instrument. It is of the double-pole type, and is well made.

The main advantages of the Schmidt & Bruckner telephones may be enumerated as follows: Improved switching devices; no cable connections; improved switch hook; guaranteed platinum contacts, accessibility and convenience in connecting up.

FIG. 1.—NEW FORM OF TELEPHONE.

FIG. 2.—DESK SET.

Messrs. Schmidt & Bruckner state that their instruments are giving excellent satisfaction in actual operation. They have been installed in many large establishments, such as Wanamaker's store, New York; McKesson & Robbins, drug house; the Lloyd Platé Glass Company, and the Central Railroad of New Jersey. The Davis Coal & Coke Company, Piedmont, W. Va., uses these instruments in its long-distance service, the lines extending 60 miles. Several of them have also been exported to Mexico and Germany.

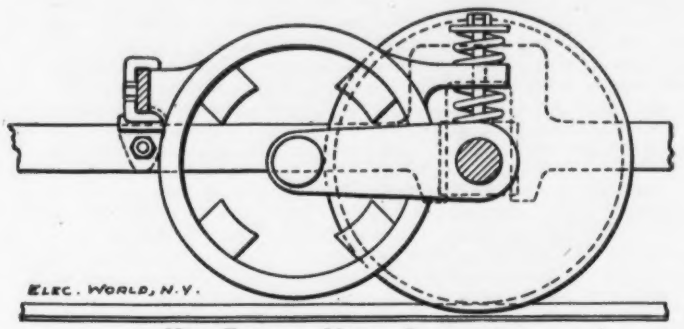
Electric Percussion Drill.

In the last issue of THE ELECTRICAL WORLD was published an illustrated description of an electric percussion drill. Through inadvertence the name of the manufacturer of this apparatus was not given. For the information of those interested we wish to state that the drill was designed by Mr. H. N. Marvin, and is manufactured by the Marvin Electric Drill Company, of Canastota, N. Y.

A New Motor Suspension.

The Walker Company, to avoid restrictions imposed upon it by the recent decision as to motor suspensions, has brought out a new suspension, which ingeniously avoids those limitations.

The new arrangement, which is shown diagrammatically in the accompanying drawing, does away with the Walker double spring suspension, and substitutes therefor a single spring suspension, with the spring on the end of the motor frame over the main axle instead of on the other end, as it is on most suspensions, and as described in the original Sprague patent. The link between the



NEW FORM OF MOTOR SUSPENSION.

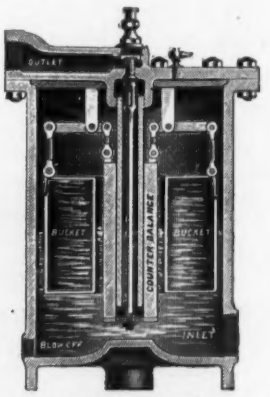
main axle and the armature shaft is retained to provide for the maintenance of a proper distance between centres of the gears, and the back suspension of the motor on the frame is pivoted in such a way that it can oscillate slightly to allow the motor to rise and fall without straining the parts.

Separator with Automatic Discharge.

The automatic and current removal from the receiver of a separator of the water and oil divorced from the steam is important, and it is a matter of much surprise that greater attention is not paid to it.

The Bundy separator, with automatic discharge, removes currently the water and oil entering the receiver of the separator and places beyond possibility the flooding that must result disastrously. The automatic contrivance adapts itself to the varying conditions perfectly. Its capacity, the makers claim, is far in excess of maximum requirements. The Bundy separator is not affected in its operation in the slightest degree until the receiver is entirely filled, after which, of course, the water and oil must pass through without being removed. Where the discharge valve is left partially open to permit of its escape there is much steam wasted, the cost of which would soon equal the cost of the automatic discharging contrivance.

SEPARATOR WITH AUTOMATIC DISCHARGE.



AUTOMATIC DISCHARGER.

By means of a series of levers the moving parts of the automatic discharger of the Bundy separator work positively and with abundant power for all steam pressures, even the highest. The discharge is controlled by a balance valve that neutralizes the pressure, and the seat of the valve is made of phosphor-bronze to prevent sticking. The initial working force is produced by a bucket sinker filled with water and a counterbalance weight, which force, however, is multiplied twelvefold by virtue of a series of levers. When the water rises higher than a certain point, the counterbalance becomes comparatively the heavier and opens the discharge valve. When the water is sufficiently discharged the bucket sinker becomes the heavier, and closes the discharge valve. Gravity or weight performs both functions, being actuated by the different volume of water displaced by each respectively. When the water comes in sufficient volume there is a continuous discharge, otherwise it is intermittent. In any case the water is discharged from the bottom of a deep-water seal, through which the steam cannot pass and be wasted.

The A. A. Griffing Iron Company, 66-68 Centre Street, New York, is the manufacturer of this device.

Making Belts for Thirty Years.

In 1866 the New Jersey Zinc Works put in a large engine requiring a 48-inch three-ply belt. This belt was the widest and heaviest ever called for up to that time, and belt makers were requested to submit models and give a description of their proposed method of making the belt. There were as many methods proposed as there were bidders for the contract. Mr. Charles A. Schieren was the successful bidder for the work. The belt was the first one ever made in sections, and for many years afterward similar belts were furnished. With the advent of electric lighting came a demand not only for very wide belts, but belts of great pliability combined with strength, in order to transmit the enormous power required in running at high speeds. To meet these requirements Mr. Schieren invented the electric belt, which has become widely known, using a stuffing specially prepared for the purpose of giving pliability without loss of solidity. He also invented new and powerful stretchers for the purpose of stretching wide centre pieces of leather to give them a uniform tension over the entire surface, and adopted parallel joints for all main belts made in sections, thereby giving the belt additional strength transversely.

In 1886 Mr. Schieren invented the American patent joint link belt. This form of belt is pliable transversely, and can be run on crown-faced pulleys. Mr. Schieren's most recent invention is the perforated electric belt, for use on high-speed dynamos and generators. The success of properly perforated belts in high-speed work has been abundantly demonstrated.

The present firm of Charles A. Schieren & Co. was founded on April 1, 1868, by Charles A. Schieren, who then had two employees. By close application and study of the ever-changing demand of this progressive age Mr. Schieren soon established a prosperous business, which gradually grew to occupy the high position in the belt industry that it does to-day. Beside having agencies in the principal American cities, the firm has foreign connections all over the world. Their tannery at Bristol, Tenn., covers ten acres, and has a capacity of 60,000 heavy belting hides per year. The firm is also a large tanner of lace leather, and operates a large plant in the Borough of Brooklyn.

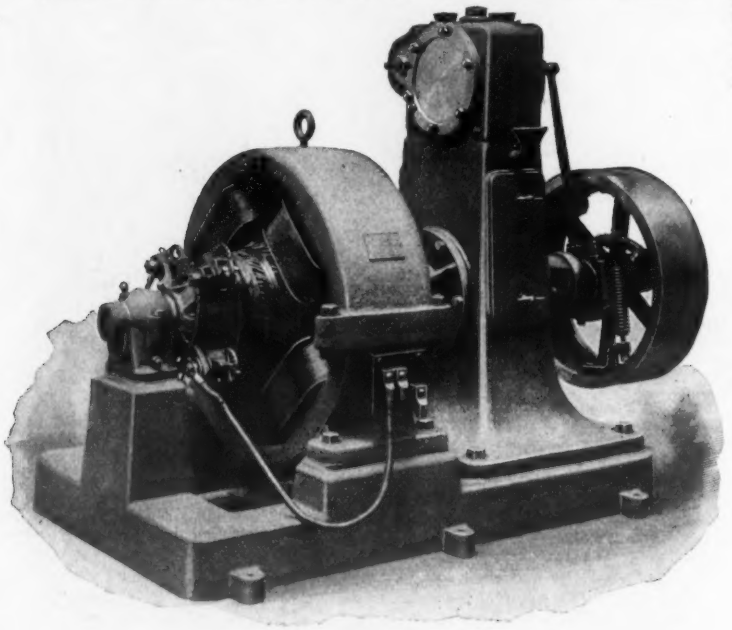
A Compact Isolated Plant.

The direct-connected unit illustrated herewith commends itself on account of its compactness. While this is a desirable and necessary consideration in many installations, it is by no means the only one in respect to this outfit. The engine is a well-known type, and will be readily recognized by many of our readers. It is the Case automatic high-speed engine, which is now manufactured by the New Britain Machine Company, New Britain, Conn., successor to the J. T. Case Engine Company.

This engine is designed for small powers, and among its chief features are simplicity, direct action, compactness and lightness of moving parts. The company manufactures this engine in three main types, viz., the Pedestal engine, the Bracket engine and the Hanger engine. The Pedestal engine may be bolted to a floor or other suitable foundation; the Bracket engine is intended to be fastened directly on the wall in installations where floor space is not obtainable, and the Hanger engine is designed to be bolted to overhead beams. Engines of different varieties for special work are also made.

The piston rod of the Case engine is connected directly to the crank shaft, and the rocking motion of the cylinder is slight, because of the almost perfect steam balance. The regulation is effected by a sensitive governor, no change of speed being noticeable in widely varying loads.

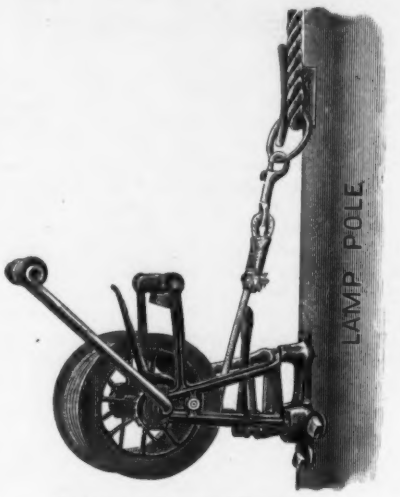
The engine illustrated herewith develops 13.3 horse-power with 80 pounds of steam. It runs at a speed of 550 r. p. m., and is direct-connected to a Bernard dynamo of 7½-kw capacity, made by the E. G. Bernard Company, Troy, N. Y. The dynamo is of the multipolar type, and, coupled to the Case engine, the combination forms a very compact unit. In this connection it is interesting to note that the United States Lighthouse tender "Mangrove," which is figuring conspicuously in affairs connected with the "Maine" disaster in Havana harbor, is equipped with one of these direct-connected outfits.



Direct-Connected Unit.

Detachable Electric Light Windlass.

The windlass shown in the accompanying illustration is designed to raise and lower electric lamps for trimming. Only one windlass is required to each trimmer, and it can be attached or detached in a second's time. Each lamp pole is provided with a malleable iron pole socket, which is permanently and securely fastened to the pole by three lag screws, and when the windlass is once attached to the socket it cannot become loosened by accident, making it as safe as if it was bolted direct to the pole. It is very light, strong and neat, being nickel-plated and enameled, and all parts liable to wear are adjustable. This device is made by Mr. E. M. Carr, New Castle, Ind.

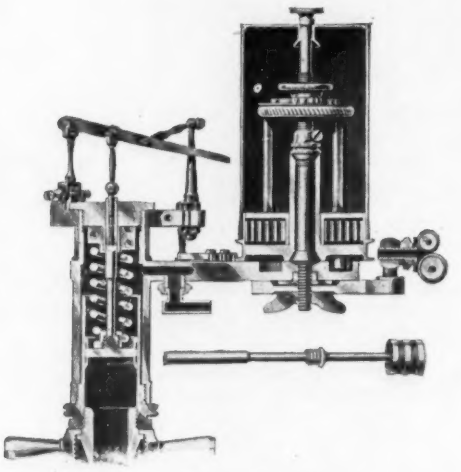


Electric Light Windlass.

Improved Steam Engine Indicator.

In these days of close competition the most rigid economy in the operation of steam plants is required. No one instrument has tended more to secure this result than the steam engine indicator, and this fact is directly responsible for the largely increased use of the instrument. Ten years ago an indicator was to most engineers a mystery, while at the present time it would be a difficult matter to find an electric light station in which a complete indicating outfit does not form a part of the regular equipment. Therefore, anything new in the indicator line will be of interest to those of our readers who are concerned in the operation of steam engines.

We illustrate herewith a sectional view of the improved Robertson-Thompson indicator manufactured by Messrs. James L. Robertson & Sons, 203 Fulton Street, New York City. In this instrument a rigid and durable construction is noticeable. This is to enable it to stand without injury the severe and exacting requirements of modern high speed and high pressure service, and this feature, combined with the lightest moving parts permissible, pre-eminently fits the instrument for such duty. The pencil machine is of the latest improved Thompson type, and is arranged to secure a perfect multiplication of the piston movement and at the same time facilitate adjustment and change of springs. That annoying bugbear of all indicator users, viz., the leakage of steam, is avoided in this instrument by means of a neat swivel elbow, which enables the operator to turn the "blow" in any direction at pleasure. The piston springs are standardized in the most careful manner by the aid of a mercury column.



Improved Engine Indicator.

News of the Week

Financial Intelligence.

THE EDISON ELECTRIC ILLUMINATING COMPANY, of Brooklyn, reports gross earnings for January of $89,381, an increase of $5,633, as compared with the same month of last year, and net $44,002, an increase of $1,605.

THE REPORT OF THE METROPOLITAN STREET RAIWAY COMPANY, New York City, for the quarter ended December 31 last, shows a net increase in earnings, as compared with the corresponding quarter of 1896, of $118,484. The gross earnings were $2,383,458; operating expenses, $1,208,769; net earnings from operation, $1,174,688; other income, $150,918; gross income, $1,325,607; fixed charges, $789,006. The net income for the same quarter in 1896 was $418,116. The general balance sheet shows a surplus of $1,737,198.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Feb. 28 1898.

THE WESTERN UNION TELEGRAPH COMPANY has sent a large force of newspaper telegraphers to Key West, Fla., to handle the Cuban news dispatches. Recent events in Cuba have given rise to such a mass of news matter that the ordinary force is entirely inadequate to handle it. Seven telegraphers left the city for the South on Wednesday night of last week, and three were sent several days prior.

THE ERICSSON TELEPHONE COMPANY, 10 Warren Street, New York, has just been incorporated to take over and conduct the business formerly carried on by Messrs. Smith & Patterson. Mr. L. P. Smith is president of the new company, Mr. John F. Hemenway secretary, and Mr. William C. Nelson vice-president. The Ericsson Company is the sole agent in the United States for the well-known telephones manufactured by A. B. L. M. Ericsson & Co., at Stockholm, Sweden. The Ericsson telephone is so well known as not to need any introduction to the readers of THE ELECTRICAL WORLD.

THE WORK of introducing the underground trolley system on the One Hundred and Twenty-fifth Street and Amsterdam Avenue line of the Third Avenue Railroad Company will, according to Mr. Edward Lauterbach, counsel for that company, probably be commenced in the spring. Similar improvements on the Forty-second Street, Boulevard and Manhattanville and the Dry Dock, East Broadway and Battery line will also begin in the spring. The One Hundred and Twenty-fifth Street line is now operated by cable; the other two by horses. The Third Avenue line, also cable, will ultimately be equipped with the underground electric system.

THE ONE HUNDRED AND TWENTY-SECOND MEETING of the American Institute of Electrical Engineers was held at 12 West Thirty-first Street, February 23. President Crocker was in the chair. About seventy-five members and guests were present. A paper on the "Single-Phase Induction Motor" was read by Mr. Steinmetz, and was discussed by Prof. W. S. Franklin, Dr. A. E. Kennelly, Messrs. E. E. Ries, Townsend Wolcott and others. At a meeting of the executive committee in the afternoon the following associate members were elected: Frank Broili, San Francisco, Cal.; Samuel Byington Libby, West New Brighton, N. Y.; Otto T. Louis, New York City; James A. Mortland, Cedar Falls, Ia.; Chas. H. Schum, New York City; C. E. Sedgwick, Berkeley, Cal.

THE BROOKLYN ELEVATED RAILROAD COMPANY on February 23 awarded to the Walker Company a number of important contracts for the equipment of its lines with electric power. President Uhlman, of the Brooklyn elevated road, stated that the structure of his company would be immediately extended to the Brooklyn terminus of the bridge, and connection would be made by which the cars would run across the bridge. The Fifth Avenue line will be first equipped, and the first order calls for twelve motor cars, each fitted with four Walker 80-hp motors. Other cars will be ordered until the entire line is equipped. The Sprague multiple unit system will be adopted in connection with the operation of the Walker motors, and the third rail method of distributing current will be used. The new cars will be equipped with Christensen air brakes. It is stated that the power will be obtained at first from the stations of the Brooklyn Heights Railroad Company until the elevated railroad company arranges its plans for its own power house.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Feb. 26, 1898.

THE PAIRPOINT MANUFACTURING COMPANY, of New Bedford, Mass., which recently went into the hands of a receiver, is continuing business, and there is every reason to believe that it will keep going right along without interruption. There is talk of an organization of the company's affairs, but as yet nothing definite can be stated as to this. The business, however, will not close up. The electrical glass goods for which this company has an excellent reputation will continue to be produced, and their quality and variety maintained.

PRESIDENT C. P. CLARK, of the New York, New Haven & Hartford Railroad Company, spoke before the New England Club recently on the subject of the competition between electric and steam railways. The railroad commissioners, he said, have decided that an old law in this Commonwealth, providing that after the lease of one railroad by another the accommodation shall not be diminished, must be complied with. Standard roads are thus called upon to run trains which do not pay one-fourth of the cost of running them because the construction of parallel electric railways has taken away most of their traffic. Some relief should be found, if possible, by which the interests of the steam railways may be protected. Electricity, he said, which is ordinary steam power developed and conducted or made use of at various points away from the engine itself, affords a remedy for this in certain cases and in certain conditions. There is no longer any question about that. The third rail experiments on the New Haven road show that with an adequate volume of business the requisite number of trains and the train service required may be maintained without serious results, but on some light lines and side lines to keep a locomotive with its engineer and its fireman, with a baggage master in the baggage car, and a conductor to conduct his train, and a rear brakeman to look after accidents in the rear, is a burden which is entirely incommensurate with the revenues received. There is one electric railroad in the Commonwealth, he stated, which had taken from the New Haven Railroad in Massachusetts more than 90 per cent. of its revenue, and we are obliged to pull a train backward and forward with five men doing nothing, earning nothing—at a loss.

PHILADELPHIA NOTES.

Branch Office of THE ELECTRICAL WORLD,
929 Chestnut Street,
PHILADELPHIA, Pa., Feb. 26, 1898.

MESSRS. HOUSTON & KENNELLY have removed their offices to the Crozer Building, 1420 Chestnut Street, this city.

MR. WILLIAM MYERS has been appointed Philadelphia representative of the C & C Electric Company, of New York City. Mr. Myers was formerly the assistant of Mr. Frank D. Sweeten, formerly representative of the C & C Electric Company, who has just resigned to become a member of the firm of Vallee Brothers & Co.

Mr. FRANK D. SWEETEN, formerly manager of the Philadelphia office of the C & C Electric Company, of New York, has been admitted as a member of the firm of Vallee Brothers & Co., of this city. Mr. Sweeten has been engaged in the electrical business for the past ten years. Prior to his engagement with the C & C Electric Company he was manager of the Delaware Electric & Supply Company, of Wilmington, Del.

THE PARTNERSHIP between Messrs. R. Barclay Twining and Stephen D. Large, who traded under the firm name of Large & Twining, at 321 Chestnut Street, this city, was dissolved on February 18, by mutual consent. The business will be continued at the same place by Mr. Large, under the firm name of Stephen D. Large & Co. Mr. Twining is authorized to settle all debts due to and by the firm of Large & Twining.

THE H. C. ROBERTS ELECTRIC SUPPLY COMPANY, 831 Arch Street, this city, has opened a well-stocked store at this address. The company will endeavor to make prompt shipments and deliveries, and try to gain the custom of the electrical trade by strict attention to its needs and requirements. The Roberts Company represents the Bryant Electric Company, of Bridgeport, Conn.; the D. & W. Fuse Company, Providence, R. I.; the Gibbs Electric Manufacturing Company, Hartford, Conn.; the Clifton Manufacturing Company, Boston, Mass., and A. O. Schoonmaker, New York City. The Roberts Company also carries a stock of O. K. incandescent lamps, besides a full line of all the products of the different concerns named above. Mr. Roberts' friends wish him success in his new enterprise. He was formerly a member of the firm of Vallee Brothers & Co.

MR. DAVID R. WALKER, chief of the electrical bureau, has presented his fourteenth annual report of work done by his department. During 1897, 28,632 feet of conduit with 203,591 feet of duct were laid by the bureau. Spare ducts in the city's conduits are rented by private corporations. The city has conduit facilities for a large quantity of service. The cable laid during the year between Callowhill and South Streets has enabled the bureau to place underground all its wires in the old city proper. The city is protected by 932 fire signal boxes. Considering the size of the territory, Mr. Walker considers this number exceedingly small, and owing to the lack of funds he is not able to meet the demand for boxes in such places as asylums, hospitals, schools, etc. The bureau has under its supervision 889 sets of telephones. Mr. Walker states that the action of the Union Traction Company in introducing large negative returns after the destruction of the Thirteenth Street power house last spring, and the effective bonding, averted any material damage by electrolysis to the city and other underground cables. The Union Traction Company has been continually at work during the year introducing new returns, new bonds, etc., to prevent leakage of current and to obtain as nearly as possible satisfactory return circuits. Mr. Walker refers to the cast welded bond introduced during the year, but expresses the fear that the experiments have not been successful. There are in Philadelphia 7119 electric street lamps. The fines for imperfect service during the year amounted to $3,611.87. The license charges on poles and wires erected were $36,049.50.

SOUTHERN NOTES.

WASHINGTON, D C., Feb. 26, 1898.

STEPS HAVE BEEN TAKEN and the money subscribed for completing a telephone line from McDowell to Williamsville, and also from Hightown to Valley Centre. With these improvements all parts of the county will be connected with Staunton and all important towns in the valley counties.

A RECEIVER has been appointed for the Roanoke Street Railway Company and the Electric Light & Power Company, of Roanoke, Va. A proposition has been made to consolidate these two companies, and it is understood that the appointment of a receiver was made necessary in order to wind up the affairs of the two concerns before the consolidation could be effected. Bills have passed both branches of the Virginia Legislature, providing for the consolidation of the two companies.

AN ELECTRIC RAILWAY from Newcastle Ferry to Richmond, Va., is one of the possibilities of the future. It is thought that such a road would do a big passenger business, as it will pass through the battlefields of Cold Harbor, Beulah Church, Gaines' Mill and others, and also pass directly by Cold Harbor National Cemetery. The road will also run through the centre of the great trucking interests of Hanover, and will reach at Newcastle Ferry, on the Pamunkey River, some of the richest grain and grass lands in Eastern Virginia. Grain, wood, lumber, feed and all kinds of freight will be lightered up and down the river to the road, to be taken to Richmond, and thence to other markets.

COL. O. G. STAPLES has ordered the telephones belonging to the Chesapeake & Potomac Telephone Company removed from the three hotels operated by him. This is one of the moves of the business men in the war against the regulations of the telephone company that has been declared, and which each side promises to fight to a finish. This is also a result of the recent edict issued by the local telephone exchange to the effect that no guests shall use the telephone in a hotel free of charge. Manager DeWitt, of Willard's, is outspoken in condemnation of the telephone company's methods, and hopes to see the movement in favor of cheaper rates and a more liberal use of the telephone take definite shape and be pushed through to a successful consummation. The District Commissioners have written to the mayors of a number of the larger cities seeking information relative to the telephone charges, the number of telephones in use and how many operators are employed by the telephone companies in the respective cities. It is understood that they seek the information in order to help them make up their report to Congress, relative to the proposal to reduce the telephone rates here.

BUFFALO AND NIAGARA FALLS NOTES.

BUFFALO, N. Y., Feb. 26, 1898.

IT IS NOW STATED that the work of changing the public lighting station from Court Street to Wilkeson Street will take about five months. The building contracts will be let as soon as the plans are ready for bids. This change will go far toward solving the problem of electric distribution of power as well as light over the city.

THE CATARACT POWER & CONDUIT COMPANY is making preparations for the delivery of about 5000 horse-power in Buffalo this year, in addition to the 3500 or 80 now in use. It will go to all sorts of concerns using power. The hotel projected to cover half a square downtown will ask for it, and last week a delegation was taken to the Westinghouse works at Pittsburg by Engineer Foster, who gave the visitors a sort of initiative lesson on the use of electric power. Flour mill proprietors were in the party, and it appears to be settled that this industry will be run by electric power as soon as it is available.

BUFFALO HAS WHAT must be voted a decidedly unique electrical society, as it has neither officers nor name, but the level-headedness of the leading spirits in it is shown by the one regulation that has so far been adopted, that no set papers are to be presented and no regular business transacted. The members gather evenings at the residence of one of their number, and by a general comparison of notes seek to help one another in their work. If one of them makes a discovery or is likely to score a failure the matter comes up before the meeting, and receives the united attention of the members. Of course the membership is not large, but it is of the best to be found here, and includes C. W. Ricker, electrical engineer of the Traction Railway Company; H. G. Stott, of the Buffalo General Electric Company; A. C. Alverson and Guthrie Gray, of the Cataract Power & Conduit Company; H. G. Meadows, consulting electrical engineer; O. E. Dunlap, of the Westinghouse Company, and F. C. Lincoln, electrical superintendent of the Niagara Tunnel power house.

PITTSBURG NOTES.

PITTSBURG, Pa., Feb. 23, 1898.

NEW ELECTRIC LIGHT COMPANY CHARTERED.—On February 21 a charter was issued by the State Department at Harrisburg to the Meyersdale Electric Light, Heat & Power Company, Meyersdale, Somerset County, with a capital stock of $10,000. The directors are Hugo Lorentz, Frank Rosenberger, Thomas Rees, Arthur Lorentz, S. D. Livengood, of Meyersdale, and Harvey M. Berkley and J. A. Berkley, of Somerset.

A JOINT STORAGE BATTERY FOR THE TRACTION COMPANIES.—It is announced that the three large traction companies, viz., the Consolidated, the United and the Birmingham, have agreed upon a scheme for a joint storage battery station, to be located in the downtown district, where it can easily be charged from or discharged into any of the three trolley systems. The energy given to the battery, or received from it by each system will be measured by wattmeters, and the expense of maintaining it will be divided pro rata, according to the demands made by each road. By joining forces in this way it is thought that the various lines in the downtown district will be insured against being tied up on account of fires, etc., and in case of emergency, such as an accident at one of the power houses, the battery might be large enough to run one of the systems throughout for a short time.

MILWAUKEE NOTES.

MILWAUKEE, Wis., Feb. 25, 1898.

THE MADISON STREET RAILWAY COMPANY will soon issue $50,000 5 per cent. bonds.

WAUKESHA RESIDENTS have asked the street railway officials for an extension on the north side.

THE 4-CENT FARE LITIGATION between the city and the Milwaukee Electric Railway & Light Company will be argued before Judge Seaman during the last week of March. Whichever side loses will doubtless appeal to the Supreme Court of the United States.

THE TOWN BOARD of Black Wolf has refused the request of the Citizens' Traction Company to allow a track to be laid across the town so as to connect the city of Oshkosh with the proposed summer resort which the street car company was to erect about 2 miles from the city.

AT A MEETING of the Council at Wausau, Wis., a committee of three was appointed to inquire into the cost of an electric lighting plant. There is a favorable public sentiment for the plant, notwithstanding that the finances of the city will not permit its immediate establishment.

ALL BUT FOUR ARC LIGHTS in the city of Superior were turned out as a result of the Council quarrel with the water, light and power company. The Council insists on lower prices. The water company refuses the concessions, and as the contracts expire the lights are taken out. Unless the difference is adjusted utter darkness in the city is threatened.

ST. LOUIS NOTES.

ST. LOUIS, Mo., Feb. 25, 1898.

THE OFFICERS of the St. Louis, Belleville & Suburban Electric Railway have filed an application for a franchise to run their cars through the town of Winstanley, on the turnpike.

A NUMBER of East St. Louis and St. Clair County capitalists have organized a company for the purpose of building an electric railway line from East St. Louis to Collinsville, and possibly to Edwardsville. The company has already secured the right of way over the East St. Louis lines by a system of transfers.

AN IMPORTANT ELECTRIC lighting enterprise has for its object the harnessing of the Meramec River, near Pacific, Mo. A large dam is to be constructed, and a fall of 17 feet given to the point of contact with the water wheels, which will transmit the power to the electric light plant. It is estimated that sufficient power can be produced in this way to enable the new company to underbid existing concerns on lighting contracts within a radius of 40 miles. The preliminary survey for the work has been made.

LONG CARS, full vestibuled and equipped with the latest improvements, will be put on the Cass Avenue line on Sunday. The Cass Avenue line is the first of the Hamilton system to adopt long cars, and as fast as practicable long cars will be put on all the others. Indications point to the changing of the Broadway cable line to an electric road during the coming summer. A decision in the case of the Fourth Street cable road, which is now pending in the Supreme Court, is expected at an early date. As soon as that can be properly disposed of electricity will be substituted for the cable. These changes will remove the short cars from all of the St. Louis street railways.

THE DEATH of President Rhotehamel, of the Columbia Incandescent Lamp Company, of St. Louis, will in no wise change the business policy of the company, which will continue to be as progressive in the future as it has been in the past. For the present there will be no change in the officers, as, during the past year, and particularly during the last six months, Mr. Rhotehamel had in a large measure put aside the details of the business of the company, not being sufficiently well to give them his attention. The office work of the company has been and will continue to be largely in charge of Secretary A. C. Garrison. The Columbia lamp enjoys the highest reputation, and the company proposes to keep up the quality of its product.

RECEIVER WURDEMAN, of the Ferguson Olive Branch Electric Light & Power Company, has advertised the sale of the plant and business for March 10. It is generally undertood that the present owners will make no effort to buy it in. The incorporation of the St. Louis & Ferguson Railway Company at Jefferson City has given rise to the belief that the incorporators of that company will appear as bidders at the sale, and that the St. Louis & Ferguson Railway will get its power from its own plant at the western terminus of its proposed route. The incorporators have already a franchise to run street cars from the city limits on the St. Charles rock road to the intersection of Natural Bridge Road and Hunt Avenue, and the track is laid that far. A survey will be made looking to an extension of this road to Ferguson.

COLORADO NOTES.

DENVER, Col., Feb. 23, 1898.

CANON CITY-CRIPPLE CREEK ELECTRIC LINE.—At a recent meeting of the directors of the Canon City-Cripple Creek Railway Company, which is to build an electric railway connecting the two cities mentioned in the corporate name, it was announced that the contract for the electric equipment for operating the road has been awarded to the Westinghouse Company. The generators will have sufficient capacity to operate at one time five trains of six standard gauge cars each. The power station is to be located six miles from Canon City and Four-Mile Creek. It was announced that nothing now stood in the way of the completion of the railway, and that the road in all probability would be finished from Canon City to Victor by August 1. It was

also stated that all the money necessary has been secured. The road is to be 27 miles in length, and the heaviest grade is said to be 4 per cent., and that only for a short distance. Three cars are to be operated for passengers, and eight for freight service. It is estimated that the round trip between Canon City and Victor, the terminus of the line in the Cripple Creek district, can be made in about ninety minutes. Grading on the line is now in progress.

ELECTRICITY ON CABLE ROAD.—As predicted recently in this correspondence an ordinance has been introduced in the City Council giving the Denver Cable Railway Company the privilege of changing its motive power from cable to electricity; permission is also extended to equip an unimportant line, now operated by horses. The company at the present time claims to be operating under a perpetual franchise granted at the time Colorado was a Territory, and before consequently the constitution forbade the grant of perpetual franchises. The company, however, is willing to exchange its present franchise for one running for twenty years if the privilege of using electric power is granted. The ordinance provides that some unimportant extensions be granted to enable the company to build loops at the terminals. Some objections have been made to the ordinance by city officials, who desire to have inserted in the ordinance a clause giving the municipality a certain percentage on receipts, but the cable company thinks that it is paying sufficient for the privilege of changing its motive power by abandoning a perpetual franchise for one running twenty years, especially in view of the fact that the improvement is one which will be greatly to the advantage of the residents of the city. The ordinance was referred to the committee on street railroads, which proposes to give several hearings before a decision is reached.

TELEPHONE NEWS.—The annual meeting of the Colorado Telephone Company was held in Denver on February 16. The company has considerable new work in progress and in prospect. The new building at Colorado Springs is almost completed. New quarters are urgently needed, as the facilities in the present quarters are entirely inadequate to the demands on the exchange. A contract has just been awarded to Frank Gaylor for the construction of a new building for the company in Pueblo, where the exchange was destroyed by fire some months ago. The structure will cost about $10,000, and it is expected it will be completed by next May. Considerable work will be done in extending the Pueblo telephone system next summer. The company purposes to build a new sub-exchange in Denver within the next few months. It will be located in the residence district at Colfax Avenue and York Street. A cable of fifty pairs of trunk wires will connect the main exchange with the new one. The new exchange will have a capacity of 2100 subscribers. The saving to subscribers in the residence district by the establishment of the new exchange will be considerable. At the present time it is the practice of the company to charge $5 in addition to the regular rates for each quarter of a mile over a mile distant from the exchange. This amount, however, was insufficient to compensate the company for the expenses incident to the maintenance of long lines. Hereafter subscribers who are within a mile of the new exchange will pay merely the regular rate.

TEXAS NOTES.

SAN ANTONIO, Texas, Feb. 21, 1898.

ADVICES HAVE REACHED HERE to the effect that the company operating the street railway systems in El Paso, Tex., and Juarez, Mexico, will soon change their mule traction to electric. The two systems are operated jointly, the Rio Grande being crossed by means of the international bridge.

MR. E. K. BAKER, general superintendent of the Southwestern Telegraph & Telephone Company, with headquarters at Austin, Tex., states that that company's long-distance lines will soon be completed to Corpus Christi, Tex. Material for the line between Victoria and Corpus Christi has been ordered, and the work of construction will commence at once.

APPLICATIONS FOR SPACE in Machinery Hall, fitted up for the benefit of exhibitors who will attend the convention of electric light, street car and gas men at Laredo, Tex., on March 9, 10, 11 and 12, are constantly coming in and it is now certain that the big space allotted to them will all be taken up. The electric light company of Laredo is stringing wires to the Rio Grande for the running of powerful pumps by electric current on the occasion of the convention.

SPECIAL RATES for the coming electrical convention at Laredo, Tex., March 9, 10, 11 and 12 will be granted by the I. & G. N. Railway and connecting lines in Texas, New Mexico, Oklahoma, Arkansas and Louisiana. The rates will be based on the 167-mile distance as follows: Transportation for any distance less than this will be charged at a flat rate of $5 for the round trip, and all mileage above 167 miles will be charged for at the rate of 1 cent per mile each way over and above the $5 flat rate.

MEXICAN NOTES.

MONTEREY, Mexico, Feb. 21, 1898.

A NEW POWER TRANSMISSION PLANT is being installed at Rincon Grande, State of Orizaba. The work is in charge of Norman Rowe, electrical engineer from the Westinghouse shops, Pittsburg, Pa.

THE FORMAL INAUGURATION of the new electric lighting system in the City of Mexico took place on February 14, the contractors being Siemens & Halske, of Berlin, Germany. It is said that the municipal government of the City of Mexico will save $33,000 a year by the new contract.

THE CONVENTION of electric light, street car and gas men at Laredo, Tex., on March 9, 10, 11 and 12, will be attended by a large delegation from Mexico. The Mexican National Railroad has put on a low rate of fare for the occasion, and it is expected that even the most remote sections of Mexico will be represented at this important meeting.

SINCE THE NEW CONTRACT between the Mexican Government and the Western Union Telegraph Company went into effect the commercial telegraph rates of this country have been more than doubled. The telegraph service of all the railroads in Mexico is shut down completely, in so far as commercial messages to the United States and Europe are concerned.

THE MEXICAN TELEPHONE COMPANY, of the City of Mexico, is making many important improvements in its service. The wires are being placed overhead, and the ground circuits are being changed to metallic circuits. The apparatus is of American make, being from the Western Electric Company, of Chicago. Mr. James Menzies, general manager of the telephone company, states that 25,000 feet of aerial cable is to be used in the improvements now in progress. The exchange will accommodate 1000 metallic circuits, or 2000 grounded circuits. Subscribers are now paying at the rate of $75 per year.

PACIFIC COAST NOTES.

SAN FRANCISCO, Cal., Feb. 19, 1898.

MR. J. W. GODFREY, representing the India Rubber & Gutta Percha Insulating Company, Yonkers, N. Y., is visiting this city. He will make a tour of the Pacific Coast in the interests of Habirshaw wires.

THE PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION held a meeting in this city February 15, when the subject discussed was "Switchboards." Prof. F. A. C. Perrine read the only paper presented upon the subject. The meeting was well attended.

THE FORT WAYNE ELECTRIC CORPORATION has obtained, through its San Francisco agency, the contracts for what is said to be the first electric coal mine haulage plant on the Pacific Coast. It will be installed at Tesla, Cal., for the Corral Hollow Mining Company. The contracts include a 100-kw Fort Wayne 250-volt belt driven generator, and three Walker electric mine locomotives of 50 horse-power. The total trackage is at present 12,000 feet.

SHIPBUILDING for the Yukon River routes is crowding all of the yards on the Pacific Coast, and many new yards have been established lately. The electrical business of the Coast has been stimulated by the demand for dynamos and motors for use on the steamers, and for operating tramways, etc. In addition to the dynamos for lighting the four river steamers to be built by the Alaska Commercial Company, several motors will be temporarily installed to facilitate the work of construction. The Westinghouse Electric & Manufacturing Company received the contracts for the four generating plants for the steamers, the General Electric Company the supplies, and the California Electrical Works the Rushmore projectors for the searchlights.

ALL OF THE LOS ANGELES COMPANIES affected by the conduit ordinance, which goes into effect April 10, have decided to comply with its requirements by burying their wires within the conduit area. The companies affected are the San Gabriel Electric Company, the Sunset Telegraph & Telephone Company, the Edison Lighting Company, the Los Angeles Lighting Company, the Los Angeles Railway Company and a new company which has applied for a franchise. The last named company intends to construct a conduit under the streets of the city for the purpose of conveying telephone, telegraph, electric light and power, fire alarm and other wires. The conduits will be rented to companies desiring to use them. Those interested are Martin Marsh, M. A. King, A. Hamburger and Louis Vetter.

CANADIAN NOTES.

OTTAWA, ONT., Feb. 26, 1898.

AN ELECTRIC RAILWAY between Ottawa and Metcalf is being advocated. The distance is about 20 miles, and the country through which such a road would run is quite level.

THE CANADIAN PACIFIC RAILWAY is credited with the intention of building a telegraph line to Dawson City in the spring. It will probably be extended from Quesnelle, where the lines now end.

THE EXPERIMENT of laying a telegraph cable from Port Angeles to Victoria, B. C., is deemed impracticable, owing to the tremendous strain that would be exerted on the line by the heavy tides and extremely rough water.

THE DECHENES ELECTRIC LIGHT COMPANY, of Dechenes Mills, Que., is having plans prepared for the constriuction of dams at Dechenes Rapids, intending to furnish 3000 horse-power. A new power house will also be erected, the contract for which will be let at an early date.

THE BRITISH AMERICAN LIGHT & POWER COMPANY is applying to Parliament for power to construct and operate by electricity, or other power, tramways to Dawson City, Fort Selkirk and other points in the Yukon and Northern British Columbia, also to operate heating and lighting systems.

THE YORK (ONT.) COUNTY COUNCIL is taking steps to secure legislation from the Ontario Government placing the control of street railways in the county under the jurisdiction of the County Council, with the rights of appeal by any local municipality to the Government. This would enable the county to build electric roads along the highways, notwithstanding objections on the part of any municipality.

ENGLISH NOTES.

(From Our Own Correspondent.)

LONDON, Feb. 16, 1898.

AN ELECTROLYTIC PROCESS FOR THE MANUFACTURE OF PARABOLIC REFLECTORS.—At a meeting of the Institution of Electrical Engineers on Wednesday last, Mr. S. Cowper-Coles described an ingenious electrolytic process for the manufacture of parabolic reflectors for searchlights. Hitherto these have always been made of glass, and beside their extreme cost they are very troublesome on account of their weight and of their ability to be completely destroyed by a shot. Mr. Cowper-Coles' process is as follows: A glass mould is prepared, the convex side of which is accurately shaped and polished to form a true parabolic or other reflecting surface. As the mould only requires shaping and polishing on one side it is comparatively cheap com-

pared to a glass reflector, which has to be ground on both sides. On the curved surface a coating of metallic silver is deposited, this being thrown down chemically on the glass and then polished. The mould thus prepared is immersed, with a copper anode, in an electrolyte of copper sulphate, and rotated at about 15 r. p. m. in a horizontal position. The copper adheres firmly to the silver, and is subsequently separated from the mould by placing the whole in water, and gradually raising the temperature to 120 degrees Fahr., when the metal reflector will leave the mould on account of the unequal expansion of the two. The concave surface of the reflector so obtained is, of course, an exact reproduction of the surface of the mould, and has the same brilliant polish, but it requires coating with a film of suitable metal to prevent tarnishing. Palladium is used for this purpose, as this metal is known to resist tarnishing even at fairly high temperatures. Its specific gravity is about half that of platinum, and its price about double, so that the same area would be covered at the same cost by either of the metals. A very thin film only is, of course, used. The coating of palladium is also applied electrolytically. The copper reflector is placed in an earthenware pan containing 0.62 per cent. of a solution of palladium ammonium chloride in about a 1 per cent. solution of ammonium chloride. The current used for a 2-foot reflector is about half an ampere at four or five volts, the solution being used at a temperature of about 75 degrees Fahr. The anode is of carbon, curved approximately to the shape of the reflector, and it is attached to a rod, which is made to swing to and fro to insure an even coating of the metal and also to agitate the solution to prevent the deposition of particles of foreign matter. Salt water has been thrown on the reflectors when they have been too hot to touch, the result being that the water was driven off as steam and the salt left as a white deposit on the reflector, which was easily removed with a wet cloth. A reflector recently tested at Portsmouth had a number of rifle bullets passed through it, when the beam was found to be little affected. On the other hand, the first shot fired at a glass reflector splintered it to pieces. Although palladium does not reflect light as well as a silver surface which is perfectly clean and bright, silver is found quite unsuitable, as after being in close proximity to an arc light for a short time the silver tarnishes, and the light is greatly reduced in intensity. With a palladium-faced reflector the intensity of light is found to remain practically constant, as little or no tarnishing takes place.

THE TELEPHONE QUESTION.—The telephone question is again attracting a great deal of attention in this country. It will be remembered that the Glasgow Corporation applied to the Postmaster-General for a license to erect a municipal telephone exchange, and an inquiry was instituted into the efficiency of the system already existing in that city, and into the facilities given by the corporation to the National Telephone Company for its improvement. The result of this inquiry has not yet been made public, but in the meantime the Huddersfield corporation has applied for a license, and the application has been refused by the Postmaster-General. The London County Council has also expressed its intention of applying for a license to build a competing telephone exchange system in the metropolis, where, although the service is now very good, the subscriptions are still very high. It will also be remembered that the City Commissioners of Sewers had refused to grant permission to the post-office to lay wires in the streets of London unless the latter would undertake not to rent any of them to the National Telephone Company. The post office applied to the City of London Court, and the City Commissioners were directed to grant the necessary facilities without imposing conditions. This decision has now been affirmed on an appeal to the Railway Commissioners. The Commissioners of Sewers had tried to induce other vestries and corporations to follow their example, and a few days ago the Hampstead (London) Vestry also refused to grant permission to the post office to lay mains, in exactly the same terms as the City Commissioners had done. In view of the legal decision having been affirmed, no doubt the Hampstead Vestry will also find itself obliged to grant the permission without conditions. The directors of the National Telephone Company have just published their report to the shareholders for the half year ending December 31, 1897. The report states that the income for the half year amounts to £507,602 17s. 3d., compared with £439,978 2s. 4d. for the corresponding period of 1896, an increase of £67,624 14s. 11d. The working expenses amount to £283,085 12s. 11d., compared with £245,278 13s 9d. for the same period of 1896, an increase of £37,806 19s. 2d. The net result for the half year (after deducting post office royalties, £46,069 15s. 8d., or 10 per cent. of the gross receipts) is a profit balance of £178,457 7s. 8d., compared with £154,982 8s. 4d. for the corresponding period of 1896, an increase of £23,474 19s. 4d. The rentals carried forward for the unexpired terms of running contracts amount to £473,586 17s. 10d., compared with $414,714 9s. 8d. at the same period last year. Out of the available balance of £156,435 8s. 5d. the directors recommend the payment of a dividend of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on third preference shares and 6 per cent. per annum, free of income tax, on the ordinary shares, and to transfer £40,000 to reserve, carrying forward £10,034 3s. 5d.. The National Company has also announced that, with the exception of one or two very small places in the South of Wales and Ireland, all its exchanges will for the future be open day and night, Sundays and holidays.

General News.

New Incorporations.

THE HUDSON SUBWAY COMPANY, New York, N. Y., has been formed with a capital stock of $5000. The directors are T. F. Lennon, T. F. Farrell and Edward J. Alms, New York.

THE JERSEY SHORE ELECTRIC LIGHT COMPANY, Jersey Shore, N. J., has been formed with a capital stock of $30,000. The incorporators are John M. Garman, C. H. Hill, Arthur Squires and others.

THE INSULATED CLAY CONDUIT COMPANY, New York, N. Y., has been formed with a capital stock of $10,000. The directors are E. R. Mecker, Elizabeth, N. J.; J. C. Gilbert, Brooklyn, N. Y.; T. K. Thomas, New York.

THE SOUTHERN MINNESOTA TELEPHONE COMPANY, Pipestone, Minn., has been formed with a capital stock of $30,000. The incorporators are D. N. Tallman, president; Thomas A. Way, treasurer; T. A. Potter, secretary.

THE CALIFORNIA AUTOMATIC TELEPHONE COMPANY, San Francisco, Cal., has been incorporated with a capital stock of $50,000. The directors are George H. Powers, William F. Russell, William F. Smith, James G. Spaulding and James M. Allen.

THE WEST INDIANA TELEPHONE COMPANY, Goodland, Ind., has been formed with a capital stock of $30,000. The directors are Isaac Colborn, Marvin G. Traugh, Benjamin W. Pratt, William J. Stewart, Albert E. Hartley, Fred. D. Gilman and Marcus Foresman.

THE PORT BYRON PEARL BUTTON & IMPROVEMENT COMPANY, Port Byron, Ill., has been incorporated with a capital stock of $2500. The directors are A. H. Wendt, J. W. Simonson, L. S. Pearsall, A. G. Brewster and others. The company will furnish an electric light plant for the village.

THE MANKATO CITIZENS TELEPHONE COMPANY, Mankato, Minn., has been incorporated by Lorin Cray, H. E. Hance, W. A. Funk, J. H. James, Edward I. P. Staede, F. Kron, H. A. Patterson, John C. Wise, Jr., A. J. Bierbauer, John Klein, J. B. Meagher, O. W. Schmidt, W. N. Plymat and Nic Peterson.

THE DUNKIRK & FREDONIA TELEPHONE COMPANY, Dunkirk, N. Y., has been incorporated with a capital stock of $40,000. The directors are Robert J. Moorhead, Northeast, Pa.; J. C. Moorhead, Cleveland, Ohio; S. Fred Nixon, Westfield, N. Y.; M. A. Phelps, F. W. Plato and G. H. Frost, Buffalo, and S. B. Rawson, Elyria, Ohio.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, Westchester County, N. Y., has been incorporated for the purpose of manufacturing electrical appliances. The directors are H. Ward Leonard, Charles R. Carpenter, Richard H. Mansfield, Jr., and Henry P. Bull, Bronxville, N. Y. Capital stock, $100,000.

THE KNICKERBOCKER TELEPHONE & TELEGRAPH COMPANY, New York, N. Y., has been organized with a capital stock of $7,500,000, to operate a telephone and telegraph system in New York, and from that city to Rouse's Point, Ogdensburg and Buffalo; to Montauk Point and Fire Island; to Weehawken, Hoboken, Jersey City, Bayonne, Elizabeth and Perth Amboy, N. J., and to Paterson, Newark, Orange, Plainfield, New Brunswick and Long Branch. The directors are Samuel B. Lawrence, Francis P. Lowrey and Charles L. Horton, of Manhattan, and J. B. Summerfield, H. M. Haviland, G. E. Spencer and H. C. Everdall, of Brooklyn.

Electric Light and Power.

DETROIT, MICH.—After a long wrangle between the Charlotte City Council and the electric light company over the price for street lighting, the council has ordered the company to cut out all street lights. The city is now dark.

WEST POINT, MISS.—Contracts will be let March 8 for engine, dynamo, station equipment, arc lamps, transformers and pole line. C. L. Jordan is mayor, and Walter G. Kirkpatrick, Jackson, Miss., engineer.

JACKSON, MISS.—The electric light and railway company is about to commence the installation of over 100 arc lamps and the building of about 3 miles of street railway. Mr. R. E. McKisson, of Cleveland, Ohio, is president, and Walter G. Kirkpatrick, of this city, engineer.

DES MOINES, IA.—The case of the State against the Washington Illuminating Company, of Washington, is before the courts. The plant is near the centre of the town, and the people are trying to have it declared a nuisance. In a similar suit some time ago the defendants won.

GENEVA, N. Y.—The Geneva Brush Electric Light and Power Company's property will be sold at public auction on March 14 by James M. Johnston, who is the referee appointed in the case of the American Loan & Trust Company vs. the Geneva Brush Electric Light & Power Company.

LANCASTER, PA.—The Lancaster Electric Light Company has elected these directors: B. J. McGrann, R. H. Brubaker, Gustave Groezinger, John B. Oblinger, W. L. Blaie, Byron G. Dodge and W. F. Beyer. The company intends carrying out the plans of commercial lighting without delay.

HOLLY SPRINGS, MISS.—Contracts will be let March 28 for engine, boilers, dynamo, pole line, arc lamps, transformers, pump, steel tank and tower, cast-iron mains, reservoir and building for an electric light and water works plant. Mr. Sam Finley is mayor, Mr. Walter G. Kirkpatrick, Jackson, Miss., is the engineer.

LOS ANGELES, CAL.—Some time ago the San Bernardino Electric Company submitted a proposition to the San Antonio Light & Power Company, looking to a consolidation in San Bernardino. A hundred patrons, representing 1400 lights, sent in a protest, and the San Antonio Company rejected the offer. Now a lively war rate is predicted.

NEW YORK CITY.—The commission which has charge of the task of providing for the disposition of the surface drainage of New Orleans has decided to use electric power for pumping away the enormous quantities of water, and a contract for an electric outfit for the central power house and for three pumping stations has just been made with the General Electric Company, of Schenectady.

CRESTLINE, OHIO.—Mr. R. C. Foster, president of the Cornman Company, Cleveland, Ohio, has secured a ten-year contract for an electric light plant at this place. He will erect buildings and install a complete equipment in the near future. The operating company will be known as the People's Electric Light & Power Company, of Crestline, Ohio. The Cornman Company has the contract for the electrical apparatus.

GREENSBORO, ALA.—A deal is about to be consummated whereby the water works of this place will be purchased by New York capital, and there will be installed and operated in connection with the water works a two-phase alternating electric light and power plant of 150-kw capacity, with a primary voltage of 1000 and at 16,000 alterations. Mr. Louis V. Massey, Greensboro, would like to receive information in regard to station and line equipment for such a plant.

THE ELECTRIC RAILWAY.

NEWARK, N. J.—The North Jersey Traction Company will extend its trolley line into Milburn the coming summer.

CATSKILL, N. Y.—The contract for building the trolley line of the Catskill Electric Railway to Cairo is about to be let. It is to be built this spring.

WHITE PLAINS, N. Y.—The Portchester Street Railway Company has decided to continue its line from the present terminus in this place to a further distance of 5 miles.

PITTSBURG, PA.—The Greensburg, Pittsburg & Jeannette electric street car line is tied up because of a dispute between the company and the Irwin Electric Company, which furnishes the power.

POTTSVILLE, PA.—E. F. Kitson has secured control of the charter of the proposed trolley from Lewistown to Reedsville. It was originally obtained years ago, but nothing was done with it. The new management will run the road through the most populous part of Mifflin County.

WASHINGTON, D. C.—After considerable delay the Capital Traction Company has begun running cars over the Fourteenth Street line as far as the Treasury Department. This road is operated on the underground trolley system. It is operating successfully, and the cars are running on three-minute headway.

CINCINNATI, OHIO.—Judge Taft, of the United States Court, has ordered the sale of the Main Street line of railway, which has been in the hands of a receiver for some time. Mr. P. B. Spence was appointed commissioner to conduct the sale. He is instructed to accept no bids for less than $90,000 for the part of the line running south of the Zoological Garden and $187,000 for the part running north.

MEADVILLE, PA.—The Cambridge Springs & Edinboro Street Railway Company has asked of the Cambridge Springs Council an extension of its franchise to allow it to increase the service. It desires to extend its line, operating all the line between Meadville and Edinboro. A power house will be constructed and boilers of 1000 horse-power each will be installed. If the request is granted the work can be completed by the middle of the summer.

PELHAM MANOR, N. Y.—The trolley franchise granted to the Union Railroad Company in March, 1896, has been extended by the trustees. The company gave a bond of $25,000 for the completion of the road within six months. Applications have also been received from the New York, Westchester & Connecticut Traction Company and from the Huguenot Electric Railway Company. It is evident that all these companies are desirous of reaching Glen Island.

WILKESBARRE, PA.—Mr. John Graham, the general manager of the Wilkesbarre & Wyoming Valley Traction Company, has been elected president and general manager of the Wilkesbarre & Northern Railroad Company, a recently constructed steam road, extending from Wilkesbarre to Harvey's Lake. The motive power is to be changed immediately from steam to electricity, and the road will be operated substantially as a branch of the Wilkesbarre Traction system. The Wilkesbarre & Northern people are erecting a magnificent hotel at Harvey's Lake this winter at the terminal of the road, and the improvements there will represent an investment of nearly $100,000. Harvey's Lake is the largest body of water in Pennsylvania, and is a very popular resort.

LEGAL NOTES.

WE ARE INFORMED by the Union Boiler Tube Cleaner Company, Pittsburg, Pa., that the Circuit Court of the United States for the Northern District of New York made a decree on February 8 enjoining the Sherwood Manufacturing Company, of Buffalo, N. Y., from infringing on the patents of the company first named.

JUDGE ALLEN, of the United States Circuit Court at Springfield, Ill., on December 21 last handed down a decision in the case of Addie F. Ide et al., executors, vs. Chuse et al., sustaining four patents issued to Albert L. Ide for steam engine governors, cross-head lubricators, engine frames and a lubricating device for steam engines. All of these inventions are used in the construction and operation of the "Ideal" engine, manufactured by A. L. Ide & Sons, Springfield, Ill.

AN EARLY TELEPHONE CONTRACT.—Prof. Alexander Graham Bell has brought suit against the heirs of the late Gardiner Greene Hubbard for the recovery of $59,798, and the appointment of a trustee for a trust fund of $200,000 held for Mrs. Bell by her father, Mr. Hubbard. The suit is said to be the outcome of a contract made in the early days of the telephone industry, before Mr. Bell married Miss Hubbard. By the terms of this contract as set forth in the bill just filed, Mr. Bell conveyed all his interests in the telephone both at home and abroad to Mr. Hubbard, to be held in trust for Mrs. Bell, the balance, above a certain annual sum, to remain as a trust fund. After the death of Mr. Hubbard last year it was found that the fund amounted to $200,000, which is alleged to have been left to Mrs. Hubbard, in fee simple, in violation of the original contract, by which it should have been turned over to Professor and Mrs. Bell.

ELECTRIC CAR HEATER DECISION.—The United States Circuit Court of Appeals for the First Circuit on February 18 handed down a decision sustaining the claims of the patent of James F. McElroy on electric heating. This decision affirms the one rendered on August 25 last by Judge Putnam in the same circuit. This suit was brought against the American Electric Heating Corporation and the West End Street Railway Company, of Boston, for infringement of the McElroy patent, which is controlled by the Consolidated Heating Company, Albany, N. Y. The American Electric Heating Corporation state that this decision applies to car heaters furnished to the West End Street Railway Company some years ago, which were a close copy of those made and sold by the Consolidated Company, the American Company believing at that time that the patent in question would never prove to be valid. This suit, it is added, has no bearing whatever on any of the present product of the American Electric Heating Corporation, and has no reference to the car heaters which it has been selling for the last three years.

PERSONAL NOTES.

HON. CHARLES A. SCHIEREN, the founder of the well-known leather belt house of Charles A. Schieren & Co., of New York City, was born in Rhenish Prussia, in 1842, and is consequently fifty-six years of age. He received a public school education in Germany, and came to America with his parents in 1856.

CHARLES A. SCHIEREN.

His experience in the leather belt business began in 1864, as a clerk, and by close aplication he mastered the details of the business, and became its manager in 1866. In 1868 he started a belt business of his own. It grew steadily and rapidly and expanded into an industry of an international character, as we see it to-day. April 1 of this year will mark the thirtieth year of the existence of this house. Mr. Schieren was elected Mayor of Brooklyn in 1893, upon a reform platform, and served the city for two years with distinction. He has kept in close touch with electrical development, and anticipated the needs of the rapidly growing electric light and power industry. At the meeting of the National Electric Asciation in Pittsburg, Pa., in 1888, Mr. Schieren read a paper on "The Transformation of Power by Belting," and at the Buffalo meeting of the same body, in 1892, he described the manufacture of a belt, in a paper entitled "From Tannery to Dynamo." Mr. Schieren is treasurer of the National Association of Manufacturers, which recently held its convention in New York City. He is also treasurer of the Central Cuban Relief Committee.

MR. F. A. M. BURRELL was born at Aaronburg, Pa., in 1858, his father being a Lutheran clergyman. At the age of fourteen young Burrell entered the employ of the Pennsylvania Railroad Company as a telegraph operator, leaving the service after two years to prepare himself to enter Columbia College. He began his course at the college on October 2, 1876, but was compelled to give up his studies in February, 1877, on account of the death of his father, which threw the responsibility of the support of the family upon the young man. Mr. Burrell entered the employ of Mr. Charles A. Schieren in 1877 as bookkeeper, and in 1882 was admitted to an interest in the profits of the business. By close application to business and the exercise of his native energy and ability Mr. Burrell rose step by step, until in 1888 he became a partner in the concern. Mr. Burrell is a director in the Manufacturers' Association of Kings and Queens counties, and other institutions of a semi-public nature. He is also a member of various clubs in Brooklyn, in which city he resides, and as a business man he has a most excellent reputation.

F. A. M. BURRELL.

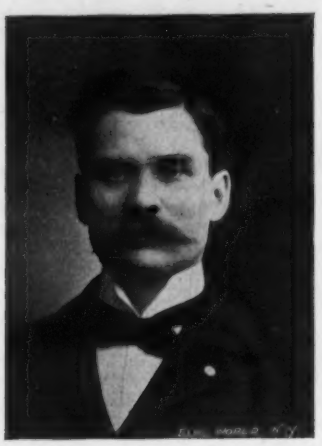
CHAS. A. SCHIEREN, JR.

MR. CHARLES A. SCHIEREN, JR., of the firm of Charles A. Schieren & Co., New York, was born in Brooklyn, N. Y., on May 8, 1869, and received his education at the Polytechnic Institute in that city. His business career began in 1887, when he entered his father's establishment as a clerk. By conscientious work and close application to business he rapidly advanced in knowledge of its details. From 1889 to 1896 he was traveling salesman for the firm, and during this time he met a great many electrical people, making many friends among them. On April 1, 1897, he was admitted as a member of the firm, and now looks after its foreign interests, which are very large.

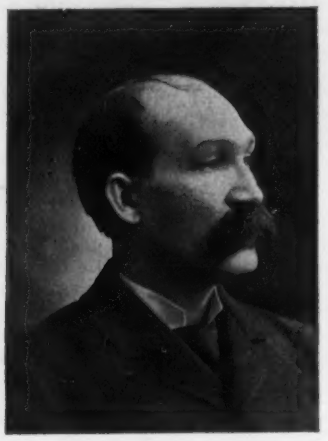
MR. A. STROMBERG, of the Stromberg-Carlson Telephone Manufacturing Company, Chicago, was born near the city of Stockholm, Sweden, in 1861. His early boyhood days were spent in the shops of his father, who was a manufacturer of grain threshers, etc. At the age of fifteen he went to Stockholm and engaged in the mechanical department of Messrs. Eller & Co., the oldest electrical concern in Sweden. Late in the seventies he was engaged in the building of telegraph lines between the largest cities. The year following he put up some of the magneto telephones that were put to use in that country, and early in 1879, when the company received the first pair of battery transmitters that were brought to use there, he assisted in the test. When the Bell Company began putting in its exchange at Stockholm Mr. Stromberg entered its service. After the completion of this exchange he put in many other exchanges for the same company throughout the Northern Peninsula and in Denmark. He came to the United States in 1884, and obtained a position with the Bell Company in Pennsylvania. In 1885 he took a position with

the Chicago Telephone Company, with which concern he remained two years. During this time he invented many new devices, some of which are still being used by the Bell Company. He afterwards served in other capacities, and in 1890, when the Chicago Electric Protective Company was organizing, to compete for the burglar protection business in Chicago, Mr. Stromberg was placed at the head of the electrical department. This company's principal patents are of his invention.

MR. A. CARLSON, of the Stromberg-Carlson Telephone Maunfacturing Company, Chicago, was born in 1854, near Borsa, Sweden. He came to America late in the seventies, and after spending some time in a number of large cities of the East and North he located in St. Paul in 1880. He afterward went to Texas and later came to Chicago. He spent several years in the various branches of the electrical business, doing mechanical and contracting work. Mr. Carlson's first telephone experience was with the Chicago Telephone Company in its mechanical department. This position gave him an excellent opportunity to exercise his inventive ingenuity and mechanical



A. Stromberg.



A. Carlson.

skill. From the beginning of his connection with that company until the opening of the independent field in 1894, he was constantly called upon to make practical working devices out of theoretical problems. He also had charge of all repairing and testing of equipment of one of the large Bell exchanges. Early in January, 1894, both he and Mr. Stromberg resigned their positions to engage in the independent telephone field, the two having arranged to manufacture their apparatus for the Western Telephone Construction Company in Chicago. In 1895, when the battery transmitter business was opening, both Messrs. Stromberg and Carlson started in business for themselves on May 10, and organized the corporation which now bears their names.

Obituary Notes.

WILLIAM M. SINGERLY, one of the most prominent business men of Philadelphia, died suddenly at his home in that city on February 27. Mr. Singerly at one time was manager of the Germantown Passenger Railway. He was sixty-five years of age.

DENNIS DOREN, general superintendent of construction of the Western Union Telegraph Company, with headquarters at New York, died suddenly in Norwalk, Ohio, on February 25. Mr. Doren was born in Wooster, Ohio, on February 13, 1830, and was consequently sixty-eight years of age. At the age of twenty years he began his career as a telegraph line builder, entering the service of the "Wade Lines" in Ohio. He was afterward connected with other telegraph companies in similar capacities, and finally became the superintendent of construction of the Western Union Telegraph Company. Mr. Doren was superintendent of the construction corps of the military telegraph in the Department of the Potomac during the rebellion.

THE DEATH OF MR. RHOTEHAMEL.—Later advices regarding the sudden death of Mr. J. H. Rhotehamel, of St. Louis, which was noted in last week's issue of The Electrical World, are to the effect that it was caused by congestion of the brain. Early in February he went to Hot Springs for rest and treatment, taking his family with him. After commencing treatment he became seriously ill, although no alarm was felt or serious results thought of. After changing doctors he was advised to return home. He was brought home on Wednesday, February 16, and died the next morning, as already stated. The funeral was held on February 19, and the office and factory of the Columbia Incandescent Lamp Company were closed out of respect for the deceased. In the notice of Mr. Rhotehamel's death published in the last issue of The Electrical World an erroneous statement crept in, to the effect that the case of the Edison Electric Light Company et al. vs. the Columbia Incandescent Lamp Company went against the latter. On the contrary, the preliminary injunction against the Columbia Company asked for by the Edison Company was refused by Judge Hallett. The defense was "non-infringement," and was supported by a large number of affidavits and the exhibition of an array of Goebel lamps and tools, which reflected much credit upon the energy and perseverance of Mr. Rhotehamel and the Columbia Incandescent Lamp Company. Mr. Rhotehamel and his company were congratulated on the successful outcome of their efforts, which had been carried on practically single-handed.

Trade and Industrial Notes.

THE CENTRAL ELECTRIC COMPANY, Chicago, is prepared to furnish from stock India or amber mica, cut or uncut, in rings, washers, or any other standard form, a specialty being made of standard shapes for commutators.

THE NON-POLARIZING DRY BATTERY COMPANY, 625 Broadway, New York, manufacturer of the O. K. dry battery, has appointed as its Western representatives Messrs. H. V. Mann & Co., 153 Market Street, Chicago, Ill.

MR. WILLIAM MUELLER, 715 Burling Street, Chicago, a newcomer in the electrical business, announces that he has bought out the Peterson Electrical Works, Milwaukee, Wis., whose stock he will dispose of at a low price.

THE OFFICERS of the Star Electric Company, Binghamton, N. Y., are as follows: President, George S. Beach; secretary and general manager, C. E. Beach; treasurer, H. W. Doughty. These gentlemen were elected by the board of directors on February 16.

THE NOWOTNY ELECTRIC COMPANY, Cincinnati, Ohio, states that it is meeting with phenomenal success in the sale of its long burning inclosed arc lamps. Over 300 of these lamps have been sold in the city of Cincinnati alone within the last eight months, and all of them are giving satisfaction.

ALL PERSONS concerned in the generation of steam would advance their own interests by reading the essays upon boiler incrustation and corrosion, published by Mr. George W. Lord, Philadelphia, Pa. Boiler explosions and the history of natural water contamination are considered at length. A copy can be had by applying to Mr. Lord, 316 Union Street, Philadelphia.

THE CHAMBERSBURG ENGINEERING COMPANY, Chambersburg, Pa., reports that it is now very busy on ordered work, including engines and a complete saw mill plant for Liberia for cutting African hardwood. This is said to be the first plant of this kind to be shipped to these parts from the United States.

MR. FRANK R. CHINNOCK, 39 Cortlandt Street, New York, is escorting a committee headed by the president of the Board of Aldermen of the city of Geneva, N. Y., Mr. O. J. Rose, throughout New England and New York State in the examination of electric light plants. Geneva is about to install its own electric light plant.

THE DAVIS & EGAN MACHINE TOOL COMPANY, Cincinnati, Ohio, has just received an order from its Copenhagen office for eleven machines, including lathes, milling machines, drill presses, screw machines, etc. It has also received an order from St. Petersburg, Russia, for several lathes, and an order from Belgium for three machines.

MESSRS. BAKER & CO., gold, silver and platinum refiners, Newark, N. J., have just issued the fifth edition of their catalogue of their platinum products. This firm manufactures platinum utensils, wire, etc., for use in all the arts and sciences. The catalogue is well illustrated with engravings of the various appliances manufactured by the firm.

THE FILER & STOWELL COMPANY, Milwaukee, Wis., has a very complete and modernly equipped plant where it manufactures Corliss engines, steam pumps, compressors, etc. Its engines are excellently adapted for electric light and power work. Mr. T. J. Neacy, the general manager, has the company's business well in hand, and is up to date in his management.

THE CENTRAL ELECTRIC COMPANY, Chicago, has taken the Western agency for the Erickson outlet insulator. This outlet insulator is brought out to meet the demands of engineers, for a thorough and perfect protector at the ends of iron armored conduit outlets. It very effectually and thoroughly prevents possible grounding of the wires on the iron conduits.

MESSRS. G. M. ANGIER & CO., Boston, Mass., report an increasing demand for their 6.8 ampere series inclosed Paragon arc lamp, for commercial and street circuits. The firm also states that it will in a very short time place on the market a new inclosed lamp for constant potential circuits, which will be but 22 inches in length over all and which for ease of trimming and simplicity of mechanism will be unsurpassed.

THE TOOL CATALOGUE of Messrs. Montgomery & Co., 105 Fulton Street, New York, just issued, is without doubt one of the most complete of its kind. It contains 510 pages, and a vast number of illustrations of the machines, tools, etc., listed. Anything in the line of machinery, tools and supplies for all branches of the mechanical trades can be obtained of this firm. The price of the catalogue is fixed at 25 cents per copy.

THE WESTERN ELECTRIC COMPANY, Chicago, is at present recommending an electric spud as a serviceable construction tool. This spud is in the nature of a digging bar, provided at one end with a braid of open hearth crucible mining steel and on the upper end an iron tamper, thus combining a digging bar and a tamping bar in one tool. The length of the spud is 9 feet, and it digs three times as fast as an ordinary bar.

FIRE on February 18 destroyed the factory of the Kent Electric Manufacturing Company, Worcester, Mass., together will all its stock of motors, etc. The company has already resumed work in temporary quarters, and is filling a large number of orders for its machines which it had on hand. Since the fire it has been pushing things in such a manner that, viewed from the shipping standpoint, it will in about two weeks be able to get back to where it was.

THE CINCINNATI STREET RAILWAY COMPANY has closed a contract with the General Electric Company amounting, it is said, to over $100,000. It covers the necessary electrical apparatus to enable the Cincinnati Company to change over that portion of its system now driven by cable, the Walnut Hills line, to an electric system. The Boston Elevated Railway has also placed a contract with the same company for electrical apparatus amounting to the same sum.

THE WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., states that owing to the large demand for its circuit breakers, and the adoption of improved methods of manufacture, it has been enabled to greatly reduce the price of these devices. Reduction of prices with reduction of cost of manufacture has always been the policy of the company. The high finish, reliability of action and compactness of these circuit breakers commend the apparatus to wise managers.

THE CABINET MANUFACTURING COMPANY, formerly of Ashtabula, Ohio, has moved its establishment, and is now installed in its new and modern plant at Steubenville, Ohio. Its new facilities, together with the advantages secured through the recent change in management, place the company in a position to give its customers the best goods and deliver them with promptness. The company's specialty is telephone woodwork in all its branches, and it solicits specifications and trial orders.

MR. WILLIAM ROCHE, 259 Greenwich Street, New York, manufacturer of the "New Standard" dry battery, is highly pleased with the extraordinary sales of his battery. Although having been in business but three months he has been compelled to take another floor in the building in order to meet the increasing demand for his product. Last week tests were made of a battery of twelve cells of No. 1 and another battery of twelve cells of No. 2. The former delivered a current of an average of 10½ amperes, and the latter 11.

THE BISSELL, DODGE & ERNER COMPANY, Toledo, Ohio, which has heretofore maintained a branch office at Columbus, Ohio, has decided to run the latter establishment as a separate concern. In order to do this Mr. John A. Erner has sold his interest in Toledo, and purchased the entire Columbus business. Little change will be made at either place except in names, which will hereafter be F. Bissell & Co., Toledo, and J. A. Erner & Co., Columbus. The affairs of the Bissell, Dodge & Erner Company will be closed up at the Toledo office.

THE MANSFIELD TEMPERED COPPER COMPANY, of Mansfield, Ohio, states that its business has increased so rapidly during the past year that it has been found necessary to build to its works an addition that will more than triple their capacity. Among other large orders recently received for the company's tempered commutator bars have been several from England, where the bars are finding a ready sale. This company has now one of the best equipped factories in the country, with every facility for turning out large orders on short notice.

THE FOSTORIA INCANDESCENT LAMP COMPANY has just issued a very handsome catalogue of its various styles of lamps. The catalogue is very artistically designed and executed, and contains colored illustrations of window lamps and decorative lamps. The colors are very brilliant and attractive, and the lamp bases are printed in gold, representing the actual article as nearly as possible. All through the pages are very handsome illustrations of the different designs of lamps. Some of these lamps are very handsomely etched. The catalogue is really a work of art.

THE C & C ELECTRIC COMPANY, New York, informs us that it has recently taken a number of orders for electrical apparatus to be shipped to various foreign countries. It is also doing a great deal of work in the line of building special motors for other manufacturers of machinery or apparatus, in connection with which electric motors are used. The company has begun the manufacture of special motors for electrically propelled vehicles. Among the recent orders in this line is a large one from the Pope Manufacturing Company, Hartford, Conn., for special vehicle motors to be used on Columbia automobiles.

THE VIADUCT MANUFACTURING COMPANY, Baltimore, Md., is running overtime and employing 125 men in filling a very large order for its magneto bells. This company has been manufacturing these instruments for so long that its goods have obtained an excellent reputation. It is now producing a new desk set, which possesses some excellent features. There has been quite a demand for the trolley and patrol signal apparatus which was described and illustrated in THE ELECTRICAL WORLD recently. This demand only goes to show that a first-class article of this nature is required by street railway companies.

MR. CHARLES WIRT, Philadelphia, is in receipt of many letters expressing satisfaction with his improved dynamo brush. These letters come from engineers, station managers, and from those operating isolated plants, and seem to emphasize the wide popularity of the new brush. Mr. Wirt also reports an increasing demand for his iron-clad rheostats. They are constructed with cast iron surfaces on both sides, completely protecting them from mechanical injury. Other unique features of construction enable them to "stand up" under the severest conditions of work, the claim being made that they will carry more than 100 per cent. overload without injury.

AMONG THE RECENT SALES of Bundy steam specialties reported by the A. A. Griffing Iron Company, Jersey City, are the following: Terre Haute Electric Railway Company, Terre Haute, Ind., two 8-inch Bundy steam separators; Chicago General Railway Company, one No. 75 Bundy high pressure tank trap; Dayton & Western Traction Company, Dayton, Ohio, two No. 101 Bundy return steam traps; the Warren Electric Manufacturing Company, Sandusky, Ohio, one No. 101 Bundy return steam trap. Printed information respecting the uses and application of Bundy specialties will be gladly furnished by the A. A. Griffing Iron Company on application.

THE CARD ELECTRIC COMPANY, Mansfield, Ohio, has added quite an extension to its offices, and is also making large extensions to its present shop and foundry. When these improvements have been completed the company will be in a position to handle orders with considerable promptness, and it will also facilitate matters materially as to the building of the large and heavier designs of electrical apparatus. The Card Company has recently issued a very neat catalogue with illustrations and descriptive matter of its new designs in direct current, slow speed multipolar dynamos and motors, both for belted and direct service, and will be pleased to supply copies of these on application.

THE INTERNATIONAL ELECTRICAL LIBRARY which is sold by the American Technical Book Company, 45 Vesey Street, New York, is meeting with a very satisfactory demand. This work is printed in six volumes, and its object is to assist in self-education in electricity. The work includes Professor Houston's "Dictionary of Electrical Words, Terms and Phrases," and a book entitled "Recent Types of Dynamo Electric Machinery," by Messrs. Houston and Kennelly. Prof. Silvanus P. Thompson is the author of the three volumes in which he treats of polyphase electric currents, alternating current motors and recent types of dynamo electric machinery. For the everyday, busy man this work cannot fail to be a valuable aid.

THE MICA INSULATOR COMPANY, New York, Chicago and London, reports a heavy increase in the volume of business. Many of the large manufacturers, it says, are using "Micanite" segments exclusively in the construction of their generators and motors. The company has made many important improvements in its well-known insulation, "Micanite," and is turning out a fine commutator segment. It will be pleased to send a set of segments for any of the smaller machines, as sample, to electrical manufacturers or repair concerns who may make application. The company's M-I-C friction tape and "Empire" cloth are meeting with a large sale. They are used for the winding of fields and armature coils, and render the highest possible grade of insulation.

THE CENTRAL TELEPHONE & ELECTRIC COMPANY, St. Louis, Mo., which is composed of James S. Cuming and R. T. Durrett, on October 14 last succeeded to the business of the D. A. Kusel Telephone Manufacturing Company. Since that time it has more than doubled the business of the old company. The firm is progressive and fully alive to the demands of independent telephone exchanges. It has erected several exchanges, furnishing their entire equipment, and has replaced other instruments with theirs in a great many exchanges and on long lines. This company has recently purchased the entire stock of merchandise and the good will of the Missouri Telephone Manufacturing Company, which has discontinued business, and this addition to its stock and facilities places it in a position to compete for any business in its line. Quality first, last and all the time is the company's motto.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., made some changes in its management, beginning February 1. Mr. S. B. Pike, secretary of the Missouri-Edison Electric Company, has assumed the position of general manager of the Wagner Company's business. He will be assisted by Mr. W. A. Layman, the assistant general manager, who will personally direct the details of the business in all matters of an executive nature. Mr. Eugene H. Abadie will hereafter devote his entire time and effort to the sale of the company's products, and Mr. Ferd. Schwendtmann, who has so ably conducted the designing and manufacturing departments of the company ever since its inception in 1892, will continue as superintendent of the manufacturing department. Mr. H. A. Wagner, who is a member of the board of directors, will continue his interest in the business in an advisory capacity.

DECORATIVE AND CANDELABRA LAMPS.—A full line of multiple candelabra lamps, as well as series lamps, is now made by the Edison Decorative and Miniature Lamp Department, which has just issued a handsomely illustrated catalogue, in which all the styles of series and multiple candelabra lamps, multiple sign lamps, series decorative lamps, and lamps for special uses, such as bicycle, telephone, dental, surgical lamps and many others are described. The department has also illustrated in this little work a complete line of receptacles and sockets for candelabra and miniature lamps. The catalogue is of interest not only to all central station managers and dealers, but also to general customers, whether experimenter, physician or others using or likely to use lamps of this character. A copy of it may be obtained from the Edison Decorative & Miniature Lamp Department, General Electric Company, Harrison, N. J.

THE SAFETY INSULATED WIRE & CABLE COMPANY, 229 West Twenty-eighth Street, New York City, has just issued a very artistic catalogue of its seamless insulated wires and cables. In it is catalogued every class of wire manufactured by this well-known concern, including telephone, telegraph, electric light and street railway wires, and cables of every kind for overhead and underground use. The catalogue is very handsomely illustrated with half-tone cuts showing representative installations using Safety wire. A picture of the power plant at Niagara Falls is one of the most interesting of the illustrations. A great deal of tabular information is scattered throughout the catalogue, which includes, besides, several testimonial letters regarding the use of this company's wires and cables. It is hardly necessary to state that these letters are highly complimentary to the Safety Company's products. The catalogue also gives illustrations of many of the largest buildings in the city which are wired with Safety wire. On the back cover is represented a partial view of a large spool of Safety wire, to which is attached a shipping tag. The reproduction is very realistic.

THE NEW ENTERPRISE in which the Weston Electrical Instrument Company, of Newark, N. J., is chiefly concerned, and which was referred to in THE ELECTRICAL WORLD of February 12, is one of great magnitude. It will include four companies, each large and important in itself. Besides the Weston Electrical Instrument Company, the new industry will take in the Weston General Company, with a capital stock of $200,000; the Weston Electric Appliance Company, with a capital of $750,000, and the European Weston Electric Instrument Company, capital, $200,000. The concern last named will, we understand, supply the foreign market. The location of the new works, as already stated, will be near Waverly Station, on the Pennsylvania Railroad. The completed plant will form a colony of electrical factories, and will afford employment fo a small army of workmen, who will be housed in the immediate neighborhood. The plot of ground on which the new factories will be erected has a frontage of 1800 feet on either side of Frelinghuysen Avenue, and runs west to the Lehigh Valley Railroad and east to the Pennsylvania Railroad, the distance between the two lines being over half a mile. Specifications for the machinery needed in the operation of the factories, and for the generation of power are now being drawn up, and tenders for bids for the same will soon be issued.

Business Notice.

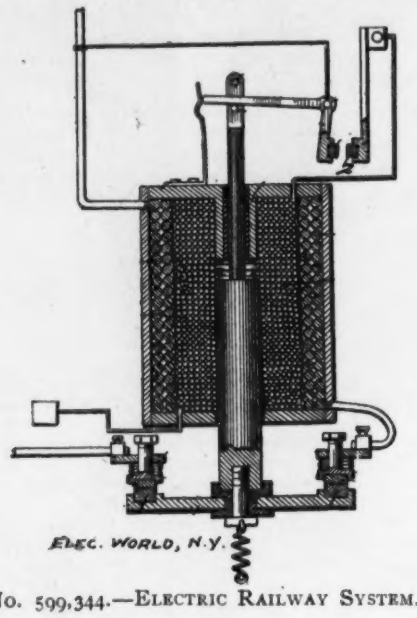
WISCONSIN FARM LANDS.—There is a rush now to the choice unoccupied farm lands along the line of the Chicago, Milwaukee & St. Paul Railway in Central Wisconsin. Good quarter sections can now be had for $7 and upward per acre, one-third cash, balance on long time at current rate of interest. For further particulars address W. E. Powell, General Immigration Agent, 410 Old Colony Bldg., Chicago, Ill.

Illustrated Record of Electrical Patents

UNITED STATES PATENTS ISSUED FEBRUARY 22, 1898.
[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

599,315. SECONDARY BATTERY; W. A. Crowdus, Chicago, Ill. App. filed Jan. 25, 1897. The process of forming negative or spongy lead elements in secondary batteries, which consists in immersing plates coated with lead oxide in a solution of sulphate of an easily oxidizable metal and sulphuric acid, and passing a current to the plates immersed therein.

599,322. INDIVIDUAL TELEPHONE CALL; T. C. Drake, Malta, Ohio. App. filed July 2, 1894. In an individual telephone system, the combination of a multiplicity of instruments connected by two line circuits and a ground circuit, and a battery and switches in said circuit, each instrument

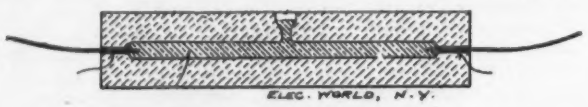


No. 599,344.—Electric Railway System.

embracing a shaft carrying a rachet wheel, a policy and contact disc, an angle lever, an adjustable armature, means for adjusting the armature, and a weighted lever to disengage the said ratchet wheel when the resistances are cut out of circuit.

599,344. ELECTRIC RAILWAY SYSTEM; J. McL. Murphy, Torrington, Conn. App. filed Sept. 24, 1897. In an electric railway system, the combination with sectional conductors, a car having a propelling motor, a storage battery and a trolley engaging the sectional conductor and the main or feed line, of an electromagnetic switch mechanism having a low resistance coil in line with the sectional conductor and the main or feed line, a high-resistance coil having a ground return and a lead joining with the low resistance coil, a circuit breaker in such lead, governed by the direct action of the opening and closing of the switch, and arranged relatively with a movable part of such switch to be opened when the said movable part of the switch receives impulse through the main or feed line circuit.

599,346. ELECTRIC WIRE HOLDING APPLIANCE; H. A. McCoy, Cambridge, Mass. App. filed Sept. 30, 1897. The combination in a portable device for holding a wire, of three parallel pieces of metal pivoted to each other by a bolt at one extremity; the two outer swinging pieces having underhooking openings in their upper surfaces coincident with each other; the central piece extending beyond the side pieces at one end, and terminating in one or more integral right-angled extensions provided with bolt



No. 599,351.—Electric Resistance Conductor.

holes, a curving notch in its upper surface registering with the openings in the side pieces when the upper surfaces of the three pieces are parallel with each other.

599,351. ELECTRIC RESISTANCE CONDUCTOR; H. G. O'Neill, Brookline, Mass. App. filed Jan. 4, 1897. A resistance conductor for converting electrical energy into heat energy, consisting of an oxide compound cast in the form of a rod or filament, having metallic terminal connections attached to each end thereof.

599,352. ELECTRIC RESISTANCE CONDUCTOR; H. G. O'Neill, Brookline, and H. B. Gale, Boston, Mass. App. filed Jan. 4, 1897. In an electric conducting device, the combination with a non-conductive support, of a layer or film of conductive oxide applied to the said support while in a fused state.

599,393. TROLLEY FOR ELECTRIC RAILWAYS; E. K. Landis, Philadelphia, Pa. App. filed March 5, 1897. The combination with a current collector adapted to engage a conducting wire, of a pivoted device having a wing on each side of said current collector, each wing extending backwardly from its pivotal attachment to a point adjacent to the extremity of said current collector, thence backwardly and obliquely, and thence forwardly toward its free end.

599,405. ELECTRIC BATTERY; C. P. Shrewsbury, London, and J. L. Dobell, Modbury, England. App. filed Dec. 24, 1895. In an electric generator consisting of a metallic cell containing an electrolyte, a chamber therein, a pipe leading from said chamber into the electrolyte and suitable means for heating the metallic cell and keeping the electrolyte in a fused state.

599,411. ELECTRICAL PRIMARY BATTERY; J. B. Whittemore, London, England. App. filed Sept. 8, 1896. A process for rendering coal adaptable for use in the liquid of primary battery cells, consisting in burning thereon, in the open, a relatively small quantity of inflammable substance, until such substance is practically all burned away.

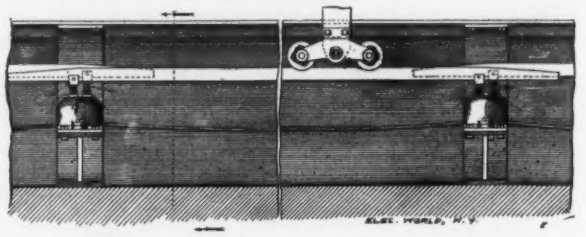
599,480. ELECTRIC ARC LAMP; O. B. Skinner and G. M. Bacon, Cleveland, Ohio. App. filed Aug. 27, 1897. In an arc lamp, the combination of an electromagnet horizontally disposed and having poles with inclined faces, an armature outside the coil and parallel therewith having inclined faces corresponding to those of said magnet poles, a carbon holder depending from said armature, a spring retaining the carbon in said holder, a stop limiting the play of said armature and a trip adapted to release said spring.

599,493. STRAIN INSULATOR; J. Clegg, New York, N. Y. App. filed Dec. 30, 1895. An insulating strain resisting fitting comprising metallic parts having their abutting faces insulated from each other and connected by an interposed layer of silica vitrified by means of a flux.

599,508. DRIVING GEAR FOR ELECTRIC METERS; G. A. Le Fevre, New York, N. Y. App. filed April 21, 1897. The combination of a registering device, a motor, and an operative driving connection between the register and motor whereby the register is moved constantly forward without reference to the direction of the motor's rotation.

599,543. SUPPORT FOR INCANDESCENT ELECTRIC LIGHTS; J. Whitaker, Schenectady, N. Y. App. filed June 19, 1897. A standard or support for incandescent electric lights consisting of a base, a spring coil secured thereto, an incandescent electric light provided with a tube, which is detachably connected therewith by means of a screw thread, and with which said spring coil is connected, and a plurality of separate frictional sections mounted on said coil.

599,553. TELEPHONE SWITCHBOARD APPARATUS; D. F. Dunderdale, Chicago, Ill. App. filed July 31, 1896. A switchboard comprising a hinged lever connected with the subscriber's line, and constituting a line terminal, which lever has a movement in more than one direction and terminals for



No. 599,604.—Electric Railway System.

auxiliary circuits adjacent to the lever, together with a spring normally holding the lever in a position against one of said terminals.

599,604. ELECTRIC RAILWAY SYSTEM; J. D. Gibbs, Chicago, Ill. App. filed March 14, 1896. In an electric railway system, in combination with a supply wire, traveling contact and a contact rail formed in sections insulated from each other, the means for supplying the separate sections of rail with current from the supply wire at the proper time, consisting of contact boxes arranged at intervals along the line of railway, each box comprising a casing with the supply wire passing therethrough near the bottom thereof and having a portion exposed, a contact plate resting upon the exposed portion of the supply wire and enlivened thereby, two bearing plates in the box, two plungers reciprocating therein and having their inner ends in close proximity to the contact plate, plates of insulation arranged upon either side of the bearing plates and insulating the same from the box, one plate having a raised portion extending between the adjoining edges of the two bearing plates, the said plungers carrying two adjoining sections of rail, and springs adapted to normally force the plungers outwardly out of contact with the contact plate.

599,635. ELECTRIC ARC LAMP; H. J. Sage, Rochester, Pa. App. filed March 19, 1897. The combination in an arc lamp, of a carbon socket supported by rods from the base of the lamp provided with a threaded extension, a cushioned seat in the upper end of the socket surrounding the carbon, and a bulbous globe supported in the seat extending above the arc and contracted closely around the upper carbon with a narrow annular intervening space between the carbon and the inwardly turned edge of the globe.

FIG. 1.—EXPOSURE ONE-HALF SECOND. SMALL APERTURE. 15-INCH STRIKING DISTANCE.

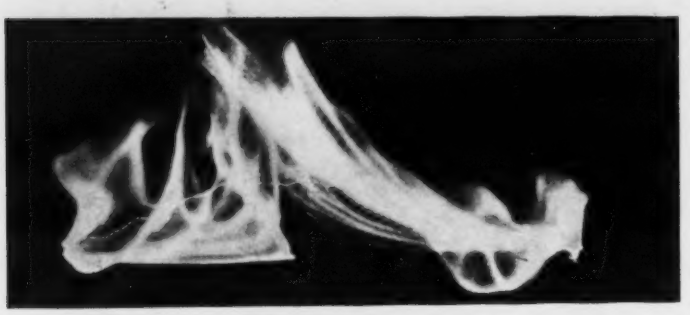


FIG. 2.—SHOWING UPWARD FLARE.

FIG. 3.—SHOWING UPWARD FLARE AND EDDIES.

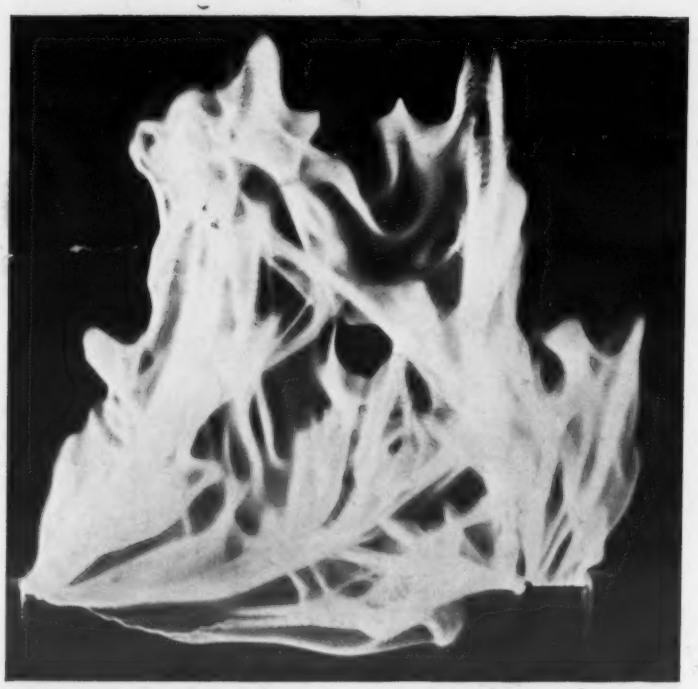


FIG. 5.—LARGE APERTURE. 14-INCH STRIKING DISTANCE. SHOWING STRIATIONS AND DARK CENTRAL SPACE.

FIG. 4.—EXPOSURE ONE SECOND. SHOWING SPIRAL EDDY BELOW THE SPARK.

FIG. 6.—FOUR SECONDS EXPOSURE. MEDIUM APERTURE.

Photographic Reproductions of 150,000-Volt Discharges.

FIG. 7.—SHOWING CONE-SHAPED EDDY.

FIG. 8.—SHOWING SOLARIZED SPARK.

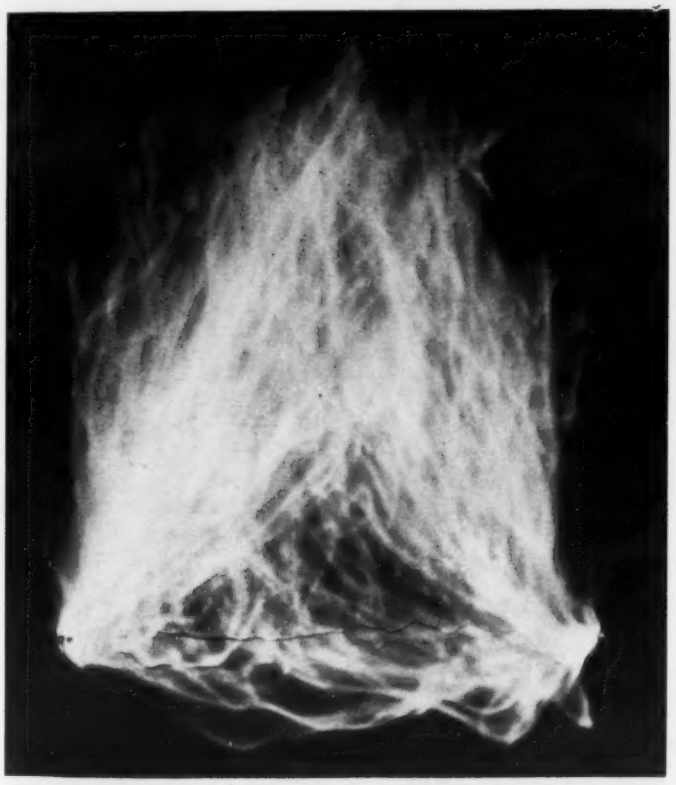


FIG. 9.—TEN SECONDS EXPOSURE. SHOWING TWO STARTING SPARKS.

FIG. 10.—SHORT EXPOSURE. SAW-TOOTH WAVE CURRENT FROM IRONCLAD ALTERNATOR.

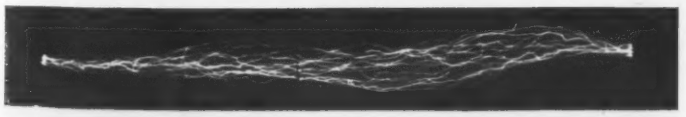


FIG 11.—EXPOSURE ONE-TENTH SECOND. HIGH FREQUENCY POWERLESS DISCHARGE. STRIKING DISTANCE, 9 INCHES.

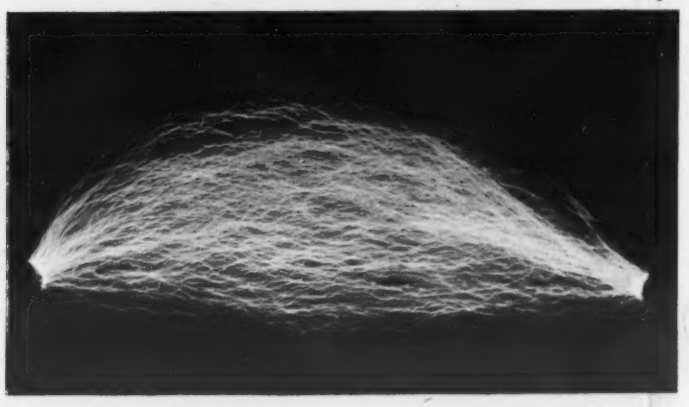


FIG. 12.—THREE SECONDS EXPOSURE. SHOWING MORE OSCILLATIONS.